



88018810

6030-110

ELK HABITAT SELECTION AND USE ON AN UNDISTURBED
SUMMER RANGE IN WESTERN MONTANA

By

Michael D. Scott

B.S., University of Montana, 1976

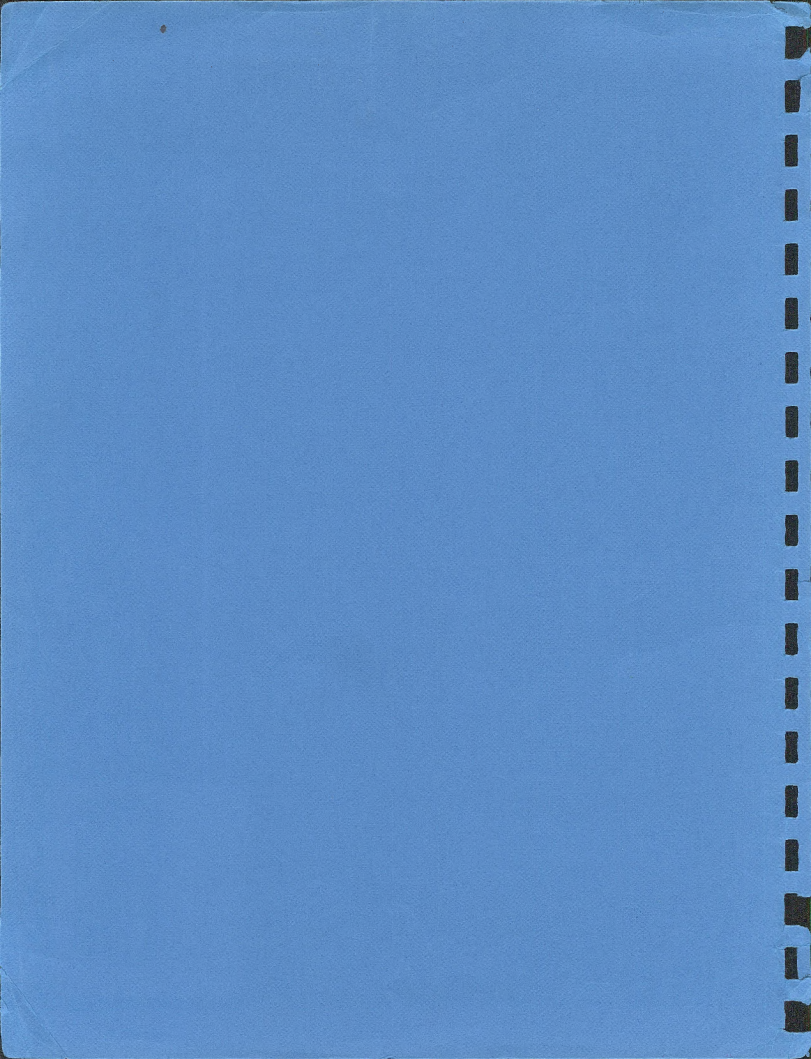
Presented in partial fulfillment of the requirements for the degree of

Master of Science

UNIVERSITY OF MONTANA

1978

QL
737
.U55
S367
1976



#21134551
D88018810

QL
737
.455
S367
1976

ELK HABITAT SELECTION AND USE ON AN UNDISTURBED
SUMMER RANGE IN WESTERN MONTANA

By

Michael D. Scott

BLM LIBRARY
SC-324A, BLDG. 50
DENVER FEDERAL CENTER
P. O. BOX 25047
DENVER, CO 80225-0047

B.S., University of Montana, 1976

Presented in partial fulfillment of the requirements for the degree of

Master of Science

UNIVERSITY OF MONTANA

1978

Approved by:

Chairman, Board of Examiners

Dean, Graduate School

Date

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100

Elk Habitat Selection and Use on an Undisturbed Summer Range in Western Montana (98 pp.)

Director: C. Les Marcum

Elk (*Cervus elaphus nelsoni*) habitat selection and use of undisturbed forested summer range was studied during summer 1976 and 1977 in the Chamberlain Creek drainage of western Montana. Belt transects extending diagonally across the study area were used to sample environmental attributes as well as to count elk pellet groups. The proportion of availability of a habitat attribute was compared to the proportion of elk pellets in that type.

Virtually all available environmental situations in Chamberlain Creek were used by elk. No habitat was preferred over all seasons but some types were consistently avoided. Elk use was always lower than the availability of slopes in excess of 30°, primary upper slopes and ridgetops, dense stands of small lodgepole pine (*Pinus contorta*) (pole-sapling successional stage), and areas farther than 450 yards (410 m) from water. During May and June 1977, the most preferred sites were clearings (either bunchgrass meadows or wet meadows and seeps) with sight distances of over 100 yards (90 m) and overstory canopies under 25 percent. *Abies lasiocarpa*/*Calamagrostis canadensis* habitat types were selected. Elk use shifted to more closed overstory canopies, primarily stands of medium to large size lodgepole pine, during July and August. Those stands typically had sight distances of 50 to 100 yards (45-90 m) and were classified as young successional stage. Mountain arnica (*Arnica latifolia*) understories were highly preferred. Pellet counts were also higher on benches, swales, and moderate slopes. Fall and winter elk use shifted to Douglas-fir-larch (*Pseudotsuga menziesii*-*Larix occidentalis*) stands on southwest and west aspects at lower elevations. The understories on preferred sites were usually bunchgrasses, pinegrass (*Calamagrostis rubescens*), or elk sedge (*Carex geyeri*).

Chamberlain Creek drainage was used most intensively during 1977, a dry year. Elk sought out stands of medium to large size lodgepole pine or mature spruce-fir (*Picea engelmannii*-*Abies lasiocarpa*), overstory canopies greater than 75 percent, moist understories, and *A. lasiocarpa*/*Menziesia ferruginea* or *A. lasiocarpa*/*Calamagrostis canadensis* habitat types. Succulent vegetation in clearcuts was heavily browsed.



ACKNOWLEDGEMENTS

I would like to thank Dr. C. Les Marcum, committee chairman, and the other committee members, Dr. Bart O'Gara, Dr. Lee Eddleman, and Dr. Philip Wright, for serving on my committee and for review of this manuscript.

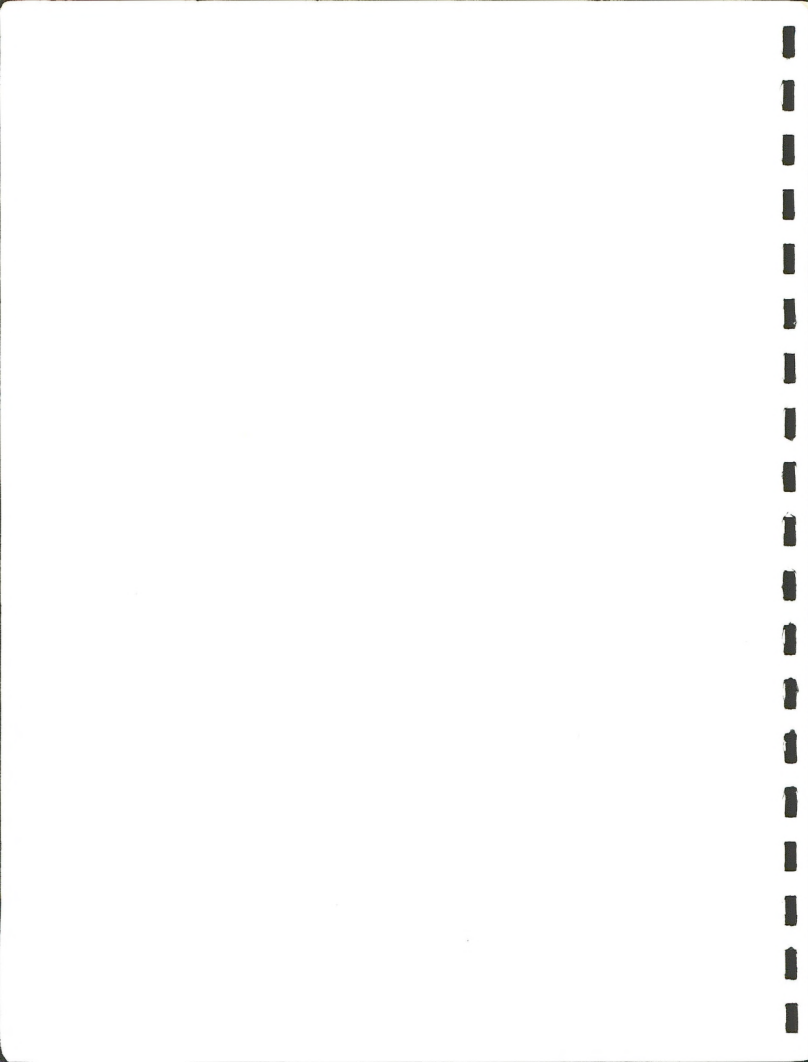
I appreciate the field assistance of Jerry Barker, Jim Lieb, Patsy Martin, Bud Clinch, and Joyce Scott. Dr. Paul Wilson provided valuable help in developing the computer maps. My special thanks go to Dr. C. Les Marcum for his patient advice, assistance, and encouragement during all aspects of this study.

This study was supported by funds from the Bureau of Land Management and the McIntire-Stennis Federal Forestry Program administered through the School of Forestry, University of Montana.



TABLE OF CONTENTS

	Page
ABSTRACT	ii
ACKNOWLEDGEMENTS	iii
LIST OF TABLES	vi
LIST OF FIGURES	viii
CHAPTER	
I. INTRODUCTION	1
II. STUDY AREA	3
Location and Physiography	3
Climate	5
Land-use Practices	7
Vegetation	8
III. METHODS AND MATERIALS	11
Habitat Description	11
Habitat Selection and Use	11
Pellet Aging and Decomposition	13
Statistical Procedures	14
IV. RESULTS	15
Observer Effects	15
Vegetation Effects	17
Pellet Aging	18
Pellet stations	18
Marked pellet groups	19
Habitat Selection and Use by Elk	22
Elk distribution	22
Topographic factors	25
Vegetative factors	34



CHAPTER	Page
V. DISCUSSION	49
VI. SUMMARY	72
REFERENCES CITED	78
APPENDIX I	83

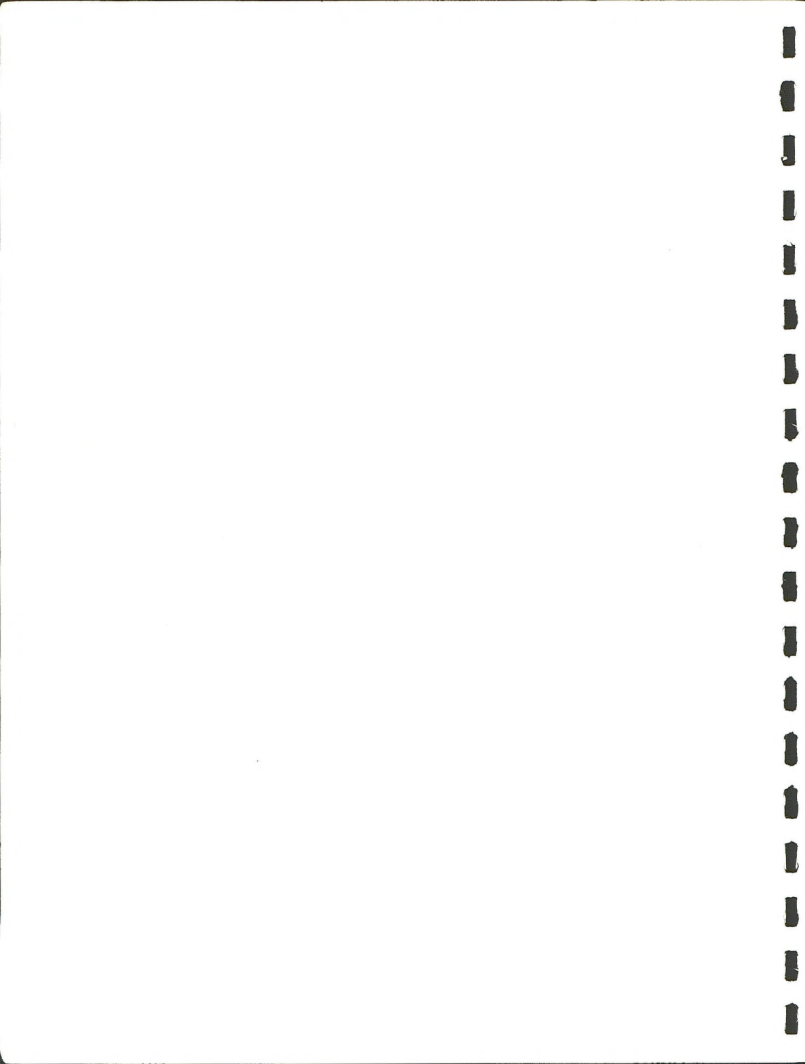


LIST OF TABLES

Table	Page
1. List of major habitat types found on the study area and the percent of the area in each type	9
2. Site characteristics of pellet-aging stations	13
3. Number of pellet groups in each age category tabulated during the three counts	15
4. List of pellet groups per 1,000 steps and percent of study area counted by each observer	16
5. Comparison of summer 1977 marked pellet count with spring 1977 total pellet count	17
6. Number of pellet groups of each age class counted at the pellet stations during September 1976, July 1977, and September 1977	18
7. Aging of marked pellet groups between spring 1977 and summer 1977	20
8. Approximate size class and stem density of arbitrary tree stand types	40
9. Percentages of availability and elk use related to subunits during 1976-1977	84
10. Percentages of availability and elk use related to elevation during 1976-1977	85
11. Percentages of availability and elk use related to slope during 1976-1977	86
12. Percentages of availability and elk use related to aspect during 1976-1977	87



Table	Page
13. Percentages of availability and elk use related to topography during 1976-1977	88
14. Percentages of availability and elk use related to distance to non-road disturbance during 1976-1977	89
15. Percentages of availability and elk use related to distance to road during 1976-1977	90
16. Percentages of availability and elk use related to distance to water during 1976-1977	91
17. Percentages of availability and elk use related to overstory canopy cover during 1976-1977.	92
18. Percentages of availability and elk use related to tree stand type during 1976-1977	93
19. Percentages of availability and elk use related to dominant understory species during 1976-1977	94
20. Percentages of availability and elk use related to habitat type during 1976-1977.	95
21. Percentages of availability and elk use related to sight distance during 1976-1977	96
22. Percentages of availability and elk use related to successional stage during 1976-1977	97
23. Percentages of availability and elk use related to deadfall height and ground cover during 1976-1977	98



LIST OF FIGURES

Figure	Page
1. Map of study area	4
2. Cumulative annual precipitation at Lubrecht Experimental Forest	6
3. Map of subunits in the study area	23
4. Percentages of availability and elk use by subunit.	24
5. Summer 1976 fresh and new elk use	26
6. Summer 1977 fresh and new elk use	27
7. Summer 1976 old and very old elk use	28
8. Percentages of availability and elk use by elevation	29
9. Percentages of availability and elk use by degrees slope	29
10. Percentages of availability and elk use by aspect	30
11. Percentages of availability and elk use by topographic category	30
12. Percentages of availability and elk use by distance to non-road disturbance	33
13. Percentages of availability and elk use by distance to road.	33



Figure		Page
14.	Percentages of availability and elk use by distance to water	35
15.	Percentages of availability and elk use by percent overstory canopy cover	36
16.	Percentages of availability and elk use by tree stand type	37
17.	Percentages of availability and elk use by dominant understory species	38
18.	Percentages of availability and elk use by habitat type	39
19.	Percentages of availability and elk use by sight distance	44
20.	Percentages of availability and elk use by successional stage	45
21.	Percentages of availability and elk use by deadfall height and cover	48



CHAPTER I

INTRODUCTION

The elk is regarded as one of western North America's most prized game animals. Consequently, a great deal of time and effort has been expended by state and federal agencies gathering basic data on elk food habits, reproductive rates, population structure, behavior, and habitat requirements. Recently, attention has turned to the relationship between elk and their summer range and the alteration of that summer range by road-building and timber harvest activities. The increasing ability of the lumber industry to utilize poorer grades of timber opens much of elk summer range to the possibility of logging and the accompanying roads and increased human access. In view of the potential conflict between timber harvest and elk habitat requirements, the Montana Cooperative Elk-Logging Study was initiated in 1970 to assess the impact of logging and roads on the behavior, movement, harvesting, and survival of elk in Montana. This study is one segment of the Montana Cooperative Elk-Logging Study.

The Chamberlain Creek drainage is the primary summer range for elk wintering in the drainages to the north and west. In contrast to many other elk summer ranges, Chamberlain Creek is



heavily forested, particularly in the upper two-thirds of the drainage which is dominated by dense stands of lodgepole pine. Perhaps because of the limited amount of merchantable timber compared to adjacent drainages and because of its inaccessibility, Chamberlain Creek has remained virtually untouched by timber harvest and road-building activity. Due to the dense overstory and topographic barriers, only very occasional livestock grazing occurred. Timber harvest planning for the Chamberlain Creek area and the initial phases of a pre-disturbance elk study were begun by Bureau of Land Management (BLM) personnel during 1971 and continued through 1974. A contract was awarded to the University of Montana in 1975 to continue the Chamberlain Creek research. The objectives of my study, conducted during the summers of 1976 and 1977, were to describe the habitat available to elk within the Chamberlain Creek drainage, the elk selection and use of that habitat, and to provide baseline data for a continuing long-term study of the effects of logging on elk in the Chamberlain Creek area.



CHAPTER II

STUDY AREA

Location and Physiography

The study area, the upper main fork drainage of Chamberlain Creek, is roughly 35 miles (56 km) east of Missoula in northwestern Powell County, Montana. Chamberlain Creek is a small, fast-flowing tributary of the Blackfoot River. The boundary generally follows the ridgetops separating the main fork drainage from adjacent drainages (Fig. 1). The eastern boundary is a very rocky, seldom-traveled road known as the "jeep trail." For most of its length, that road follows the divide separating the main fork of Chamberlain Creek from the drainages to the east: Wales, Pearson, and the East Fork of Chamberlain creeks. Similarly, the western boundary follows the divide separating the Chamberlain main fork from Bear, Fish, and Little Fish creeks and Cap Wallace Gulch. A second road skirting the headwaters of Chamberlain Creek forms the southern and southwestern boundaries.

Two topographically distinct portions comprise the study area. The northern third is dissected by several small east-west ridges of moderate slope (15-30°) which abruptly change character adjacent to

Fig. 1. Map of study area.



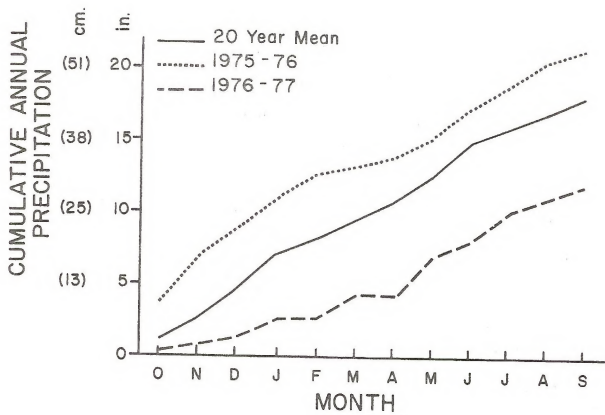
the main stream. In addition to being much steeper ($30-40^\circ$), the lower slopes are more irregular due to scattered rock outcrops and talus areas. The southern two-thirds of the study area is characterized by long, gentle-to-moderate slopes of 20° or less. Elevation ranges from 4,400 feet (1,340 m) in the main creek bottom at the northern end to 6,800 feet (2,070 m) in the southeast side.

Climate

Cool, moist winters and hot, dry summers are typical on the area. Weather data are collected at Lubrecht Experimental Forest (elevation 4,100 feet, 1,250 m) 10 miles (16 km) to the east (Steele 1978). The 20-year average daily minimum temperature is 8.2°F (-13.2°C) in January. The highest average daily maximum (82.7°F , 28.2°C) occurs in July. Annual precipitation ranges from 12 to 29 inches (30 to 74 cm) (mean = 18.1 inches, 46.0 cm); over two-thirds falls during winter and spring (December through June). Precipitation is usually lowest during July and August. The climate of the study area is probably slightly cooler and more moist than that of Lubrecht Forest.

Precipitation during 1976 was near normal (Fig. 2) except during July and August when rainfall was 70 percent above the 20-year mean. The first 6 months of 1977 were much drier than usual, despite precipitation slightly above normal during March and May. Only

Fig. 2. Cumulative annual precipitation at Lubrecht
Experimental Forest.





7.2 inches (18.3 cm) fell during December 1976 through June 1977 compared to an average of 12.3 inches (31.2 cm) for those months. Rainfall in July 1977 was twice the average for July; rainfall in August was near normal.

Land-use Practices

Although most of the surrounding drainages are grazed by livestock (cattle and horses) and some of the drainages have received extensive logging, human impact on the study area has been minimal. Two small clearcuts occur in the southwest corner and a larger clearcut at the northwest corner. However, the main portion of the study area was never logged and is essentially roadless. Because of inaccessability, only inconsequential livestock grazing occurs. The north and west boundaries of the study area were fenced during 1976 and the south boundary during 1977. Steep slopes and dense timber stands preclude livestock entry along the east boundary. Recreational use is limited almost entirely to big-game hunting in the fall. The study area is part of a larger land management unit which is closed to vehicles during the hunting season.

Of the 5,800 acres (2,350 ha) in the study area, approximately 4,000 acres (1,620 ha) are National Resource Lands managed by the BLM and 1,800 acres (730 ha) are private lands (Burlington Northern, Inc.).



Vegetation

Forest canopy covers 98 percent of the study area. An additional 1 percent is clearcuts or seed-tree cuts. Below 5,500 feet (1,680 m), the southwesterly slopes are dominated by Douglas-fir and the northeasterly slopes are dominated by Douglas-fir and western larch. A few small bunchgrass clearings occur on the ridgetops and southwesterly slopes. Because of fires near the turn of the century (Ellison 1974) lodgepole pine is the dominant tree species on two-thirds of the area above 5,500 feet (1,680 m). Subalpine fir and Engelmann spruce occur on northerly slopes and wet areas that have not burned recently.

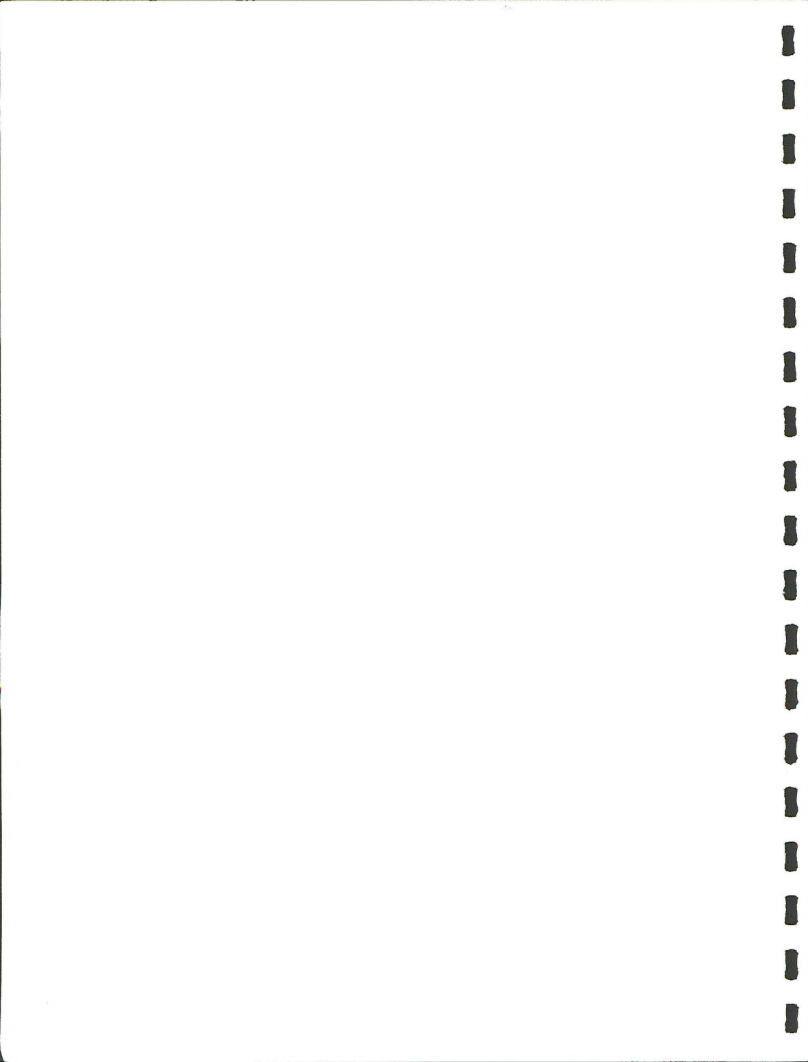
The dominant understory plants are similarly separated along an elevational gradient. At lower elevations, the most common understory dominants are pinegrass, heart-leaf arnica (Arnica cordifolia), and globe huckleberry (Vaccinium globulare). The understory in clearings and low-density Douglas-fir stands is usually bunchgrasses, primarily Idaho fescue (Festuca idahoensis), bluebunch wheatgrass (Agropyron spicatum), and elk sedge. The most common habitat types (Pfister et al. 1977) are: PSME/FEID, /CARU-AGSP, and /CARU-CARU (Table 1).

Dominant species at higher elevations are mountain arnica, beargrass (Xerophyllum tenax), globe huckleberry, whortleberry (Vaccinium scoparium), fool's huckleberry (Menziesia ferruginea),



Table 1. List of major habitat types found on the study area and the percent of the area in each type.

Habitat type	Abbreviation	Percent of study area
<u>Pseudotsuga menziesii</u> climax series		
/ <u>Festuca idahoensis</u>	PSME/FEID	2.4
/ <u>Physocarpus malvaceus</u>		
- <u>Physocarpus malvaceus</u> phase	PSME/PHMA-PHMA	0.6
/ <u>Vaccinium globulare</u>		
- <u>Xerophyllum tenax</u> phase	PSME/VAGL-XETE	1.3
/ <u>Linnaea borealis</u>	PSME/LIBO	1.2
/ <u>Symphoricarpos albus</u>	PSME/SYAL	0.9
/ <u>Calamagrostis rubescens</u>		
- <u>Agropyron spicatum</u> phase	PSME/CAPU-AGSP	1.6
- <u>Calamagrostis rubescens</u> phase	PSME/CARU-CARU	4.7
<u>Abies lasiocarpa</u> climax series		
/ <u>Clintonia uniflora</u>	ABLA/CLUN	1.3
/ <u>Calamagrostis canadensis</u>		
- <u>Calamagrostis canadensis</u> phase	ABLA/CACA-CACA	3.6
- <u>Galium triflorum</u> phase	ABLA/CACA-GATR	2.5
- <u>Vaccinium caespitosum</u> phase	ABLA/CACA-VACA	1.4
/ <u>Linnaea borealis</u>		
- <u>Linnaea borealis</u> phase	ABLA/LIBO-LIBO	2.0
- <u>Xerophyllum tenax</u> phase	ABLA/LIBO-XETE	14.5
/ <u>Menziesia ferruginea</u>	ABLA/MEFE	24.8
/ <u>Xerophyllum tenax</u>		
- <u>Vaccinium globulare</u> phase	ABLA/XETE-VAGL	26.0
- <u>Vaccinium scoparium</u> phase	ABLA/XETE-VASC	5.0
/ <u>Alnus sinuata</u>	ABLA/ALSI	4.0
Clearcut or burn		2.0
Rock		0.2
Total		100.0



and wavy-leaved alder (Alnus sinuata). The major habitat types, which all belong to the Abies lasiocarpa climax series, are: ABLA/MEFE, /LIBO-XETE, /XETE-VASC, /XETE-VAGL, and /ALSI.

The stream bottom habitat types are either ABLA/CACA-CACA or ABLA/CACA-GATR. Narrow steep-walled stream canyons are dominated by a shrub understory, primarily mountain alder (Alnus incana), red-osier dogwood (Cornus stolonifera), and Rocky Mountain maple (Acer glabrum). Shrub abundance is lower and sedge (Carex spp.) and forb abundance is greater along broad, gently-sloping stream bottoms. The wet meadow vegetation is primarily sedges and willow (Salix spp.).

The understory responds markedly to the disturbances associated with logging. Two clearcuts at the southern end of the drainage, surrounded by a forest understory of Menziesia and Alnus sinuata, are dominated by fireweed (Epilobium angustifolium), black elderberry (Sambucus racemosa), shiny-leaf ribes (Ribes lacustre), and lodgepole pine saplings 3 to 7 feet (0.9 to 2.1 m) tall. Both cuts, on gentle north slopes were completed in 1965. The seed-tree cut at the lower north end, on a 20° northeast-facing slope, is dominated by pinegrass, sedges (Carex geyeri, C. concinnoides, and C. rossii), and beargrass. Fireweed, black elderberry, and shiny-leaf ribes are present as subdominants. That cut was completed in 1968.



CHAPTER III

METHODS AND MATERIALS

Habitat Description

Fifteen belt transects, 4 feet (1.2 m) wide, were permanently established diagonally across the study area at approximately one-quarter mile (400 m) intervals. Each transect was divided into a series of segments according to changes in cover type and/or habitat type (Pfister et al. 1977). Segments shorter than 50 feet (15 m) were not differentiated. Segments that exceeded one-eighth mile (200 m) were split into two or more sections. Each segment was categorized by habitat type, understory dominants, sight distance, amount of deadfall, successional stage, and topography. Slope, aspect, and segment length (in steps) were measured. Distances to water, roads, and non-road disturbances were determined from topographic maps. Tree canopy cover was estimated from aerial photographs.

Habitat Selection and Use

The basic information describing elk use was derived from pellet counts on each transect segment. Three separate pellet counts were made, one during 1976 (17 August through 1 September) and two



during 1977 (25 June through 1 July and 25 August through 8 September).

Each pellet group was classified into age categories as described by Lyon (1973). The age categories were:

Fresh--soft, wet, dark brown, and unweathered

New--dark brown, unweathered

Old--somewhat weathered, mostly tan or brown, slightly cracked

Very old--gray, weathered, checked, falling apart

Nine cow elk were fitted with radio collars during winter 1976-1977. Seven of those animals remained almost entirely within the study area during July and August 1977. Although detailed analysis of their movements was not part of my study, I did gain supplemental information on habitat use through observations of radio-collared elk during July and August 1977. Identification of the specific habitat a radio-collared animal was using at a particular time almost always required approaching the animal on foot. I could usually approach the animal undetected even though dense vegetation necessitated getting very close. However, the animal invariably became aware of my presence, frequently within a few minutes. Once an elk sensed me, observation of that animal was discontinued for that particular day. The data recorded for each sighting were the same as those collected for the transect segments. In addition, the weather, time of day, and the animal's activity at initial contact were noted. Because of small



sample size (22 observations) and the possibility of bias (the most accessible animals were more likely to be sampled, few night observations were made), detailed results of these observations will not be reported.

Pellet Aging and Decomposition

Eighty pellet groups were collected, categorized by age, and placed beside numbered stakes on two different sites (Table 2) during early September 1976. Of the 80 pellet groups, 10 were fresh, 29 new, 25 old, and 16 very old. The pellet groups were again classified by age just after the spring 1977 and summer 1977 counts and during late June 1978.

Table 2. Site characteristics of pellet-aging stations.

	Habitat type	Elevation (feet)	Aspect	Slope	Tree Canopy
Station 1	PSME/CARU-CAGE	5,700 (1,700 m)	225°	15°	50-75%
Station 2	ABLA/MEFE	6,200 (1,900 m)	30°	5°	> 75%

All pellet groups on the transects were partially marked with spray paint during the spring 1977 pellet count. The rate of pellet aging and decomposition during July and August was estimated from the number and age class of marked groups counted during summer 1977.



Statistical Procedures

Initially, one-way and n-way analyses of variance were attempted using pellet groups per 1,000 steps as the dependent variable. However, even in the most preferred types, a substantial portion of the segments were without pellet groups. This caused the variance to fluctuate with the mean for each habitat attribute, thus violating the equal-variance assumption required for analysis of variance. A transformation of the data, the log of pellet groups per 1,000 steps plus one, corrected this problem but lacked intuitive appeal. In addition, sample size quickly became limiting when n-way analyses were attempted. Therefore, a procedure similar to that described by Marcum (1975) was used to compare the proportion of availability of a given habitat attribute, based on transect segment length, to the proportion of elk use, based on pellet counts, within the study area. The significance of the difference between proportions was determined by a Z-test (Snedecor and Cochran 1967). Datum analysis was accomplished using the University of Montana DECSYSTEM-20 computer and a series of standard statistical programs, Statistical Package for the Social Sciences (SPSS, Nie et al. 1975).



CHAPTER IV

RESULTS

The total pellet count increased throughout the study, primarily because of an accumulation of old pellet groups (Table 3). The fresh and new pellet count decreased slightly during the spring but increased again in the summer of 1977 to three times the summer 1976 count.

Table 3. Number of pellet groups in each age category tabulated during the three counts.

	Fresh	New	Old	Very old	Total
Summer 1976	36	165	449	619	1,269
Spring 1977	21	142	945	552	1,660
Summer 1977	86	514	1,095	668	2,363

Observer Effects

Four observers counted pellet groups during the course of the study. Comparisons of segments counted by different observers could be made only if there was no observer bias; or if a consistent bias existed, that bias could be accounted for in some manner. One bias appeared during the spring 1977 pellet count. Observer 3 counted



four times as many fresh and new groups per 1,000 steps and twice as many old plus very old groups as the other two observers (Table 4).

Table 4. List of pellet groups per 1,000 steps and percent of study area counted by each observer.

	Percent of study area	Pellet groups per 1,000 steps	
		Fresh and New	Old and Very old
Summer 1976			
Observer 1	47.6	2.31	12.61
Observer 2	52.4	2.44	12.65
Total	100.0		
Spring 1977			
Observer 2	43.1	1.10	14.03
Observer 3	28.2	4.10	27.98
Observer 4	28.7	1.03	13.11
Total	100.0		
Summer 1977			
Observer 2	53.3	7.16	21.29
Observer 4	46.7	7.02	20.36
Total	100.0		

Possibly Observer 3 was assigned those segments which received the highest elk use while the less preferred segments were assigned to the other observers. All elk pellet groups were painted during the spring 1977 count. The number of marked pellet groups tallied in the summer (Observer 3 did not participate) was compared to the number painted during the spring (Table 5). Transects 10 and 11 were excluded because the pellet groups on those lines were



marked with orange lacquer which did not persist as well as the yellow enamel used on other lines. Seventy-six percent of the groups marked by Observers 2 and 4 and 57 percent of those marked by Observer 3 were recounted during the summer. Therefore the count made by Observer 3 was reduced by $(0.76 - 0.57)/0.76 = 0.25$. This estimated the probable tally had those segments been counted by the other observers. No other observer bias was detected.

Table 5. Comparison of summer 1977 marked pellet count with spring 1977 total pellet count.

	Number of pellet groups		Recount percentage
	Summer 1977 marked	Spring 1977 total	
Observers 2 and 4	575	754	76.3
Observer 3	290	513	56.5

Vegetation Effects

All pellet groups on pellet stations persisted through the study, yet only 76 percent of the marked groups on the transects were recounted 2 months later. Many of the missing pellet groups probably did not disintegrate but were overlooked during the summer count. Most observers apparently missed a substantial proportion of the pellet groups. Observer 3, on the other hand, may have been unusually efficient, thereby counting significantly more pellet groups



than the other observers.

Comparisons of pellet counts among different vegetation types was valid only if the proportion of missed pellet groups was comparable among all types. With the minor exception of brushy stream bottoms (where the recount percentage was low), the density and species composition of the understory vegetation had no significant effect on the percentage of marked pellet groups recounted during summer 1977.

Pellet Aging

Pellet stations. The rate of aging of pellet groups placed at the two pellet stations was not significantly different. Combined results for both sites are presented in Table 6.

Table 6. Number of pellet groups of each age class counted at the pellet stations during September 1976, July 1977, and September 1977.

	Fresh	New	Old	Very old	Total
September 1976	10	29	25	16	80
July 1977	0	0	65	15	80
September 1977	0	0	30	50	80

Most fresh and new groups (85%) were classified old the following July (9 months later). By September 1977 (1 year later), 64 percent of the original fresh and new pellets was very old. Old



pellets tended to persist in that category, 92 percent was still old in July and 44 percent was old in September. Several very old groups were classified old on subsequent tallies (nine during July and five during September 1977). Seventy-two pellet groups (90%) were still recognizable in June 1978 (21 months later). Two of the 72 groups were classified as old and 70 as very old.

Marked pellet groups. The segments counted by Observer 3 and Transects 10 and 11 were excluded from the analysis of marked pellet group aging (Transects 10 and 11 were marked with orange lacquer which did not persist as well as the yellow enamel used on other transects). Seven hundred and fifty-four pellet groups were marked on the remaining 307 segments during the spring count. Five hundred and seventy-five marked pellet groups (76.3%) were recounted during August. All marked pellet groups were classified old or very old during the summer 1977 count.

The spring and summer counts were compared on a segment-by-segment basis to identify aging patterns of the marked pellets. Aging or disappearance of pellet groups on a segment was conclusively determined if: (a) all the spring pellet groups for that segment were the same age, (b) all the spring groups were tallied as one age class during the summer, or (c) none of the spring groups were recounted. Results were obtained for 292 pellet groups on 126 segments (Table 7).



All spring fresh and new pellets aged to old or very old within 2 months. Of the original old pellets which were recounted, roughly half were still considered old, the rest very old. Inconsistencies in distinguishing old from very old were evident; 35 groups classified very old during the spring were called old 2 months later.

Table 7. Aging of marked pellet groups between spring 1977 and summer 1977.

		Spring 1977			Total
		Fresh + New	Old	Very old	
Summer 1977	Old	6	63	35	104
	Very old	5	54	40	99
	Not recounted	3	53	33	89
	Total	14	170	108	292

The marked pellet groups and the groups placed on pellet stations aged similarly. Fresh groups rapidly aged to new, probably within a few days. All pellet groups aged to old within 2 months. The distinction between old and very old was not useful in determining the actual age of a pellet group. Generally the old stage lasted for several months. However, several fresh and new groups aged to very old within 2 months. Other pellet groups persisted as old for at least 1 year. Pellet groups classified very old on one count were often considered old on subsequent counts.



Two age classes of pellet groups were recognized for this study, fresh plus new (FN) and old plus very old (OVO). FN pellet groups represented the most recent elk use (within the previous 2 months). No particular season of use could be identified with OVO pellet groups. However, fall and winter use could be inferred in areas with low spring and summer FN counts but high OVO pellet counts. Because of snow depths, only the northeast corner of the study area is used by elk during most winters. In many areas, it is difficult to separate fall elk use from previous years' accumulation of spring and summer pellets. Thus, spring FN pellets represented May and June elk use while summer FN groups represented July and August use. Both spring and summer OVO pellet groups were considered to more nearly represent total yearly elk use rather than a particular season of elk use.

If all spring pellet groups persisted, the summer OVO count on the 307 segments should have been near 754. Instead the summer OVO tally was 1,048, at least 300 pellet groups more than the spring total. A substantial number of pellet groups probably were deposited after the spring count yet aged to OVO before the August tally. However, those pellets did not appear to have been deposited in a markedly different pattern than the FN groups and should not therefore significantly bias the results.



Habitat Selection and Use by Elk

The following convention was used to indicate the statistical significance of the difference between the proportion of availability of a habitat factor and the proportion of elk use of that factor: + or - indicated elk use significantly greater or less than availability, $p \leq 0.05$; ++ or -- indicates a significant difference with $p \leq 0.01$; lack of a sign indicates no significant difference.

The OVO pellet count represented an accumulation of pellet groups over several seasons. Therefore the OVO proportions changed very little between pellet counts spaced only a few months apart. To simplify the figures, only an average of the three OVO proportions is presented. Numerical values for all pellet counts and pellet ages, corresponding to Figs. 4 and 8-21 are presented in Appendix I, Tables 9-23.

Elk distribution. To identify yearly and seasonal shifts in elk distribution, the study area was divided into 11 subareas based on topographic and vegetative homogeneity (Fig. 3). No subunit received elk use greater than availability during all seasons (Fig. 4). Only subunit 7, the stream bottom at the northern end, received consistently low use. July and August elk use was greater than availability in subunits 3, 6, 9, and 10. Subunit 10 was also used significantly in excess of its availability during May and June 1977. The intensity of

Fig. 3. Map of subunits in the study area.

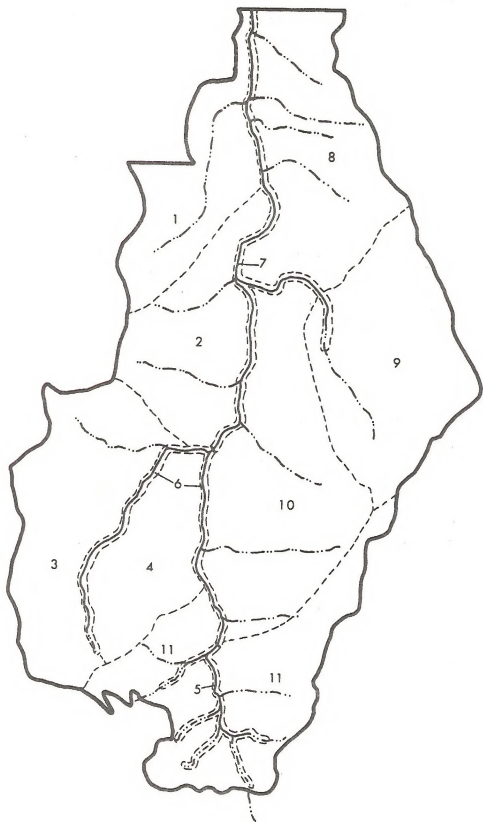
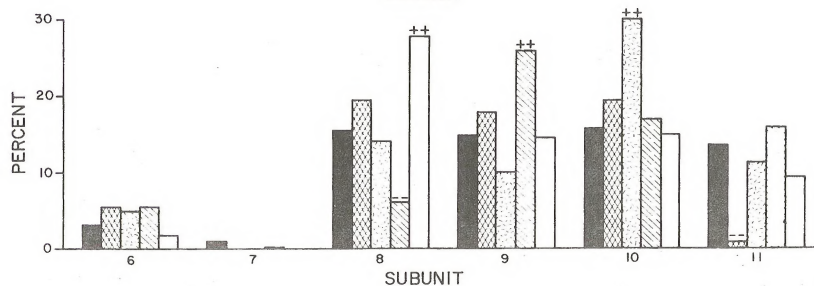
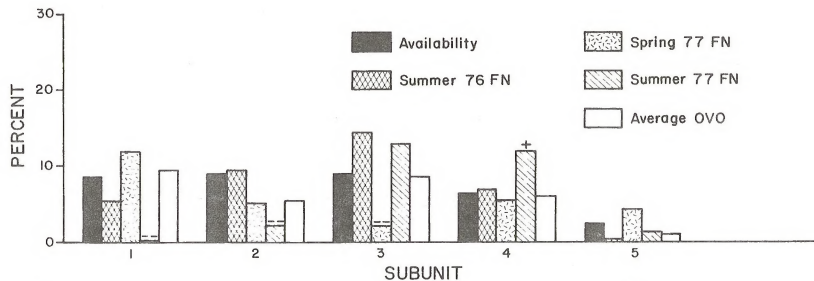


Fig. 4. Percentages of availability and elk use by subunit.





elk use in the northern subunits (1, 2, and 8) was the same during both summers. However, the FN pellet count quadrupled on the southern subunits during summer 1977 (Figs. 5 and 6). Thus the proportion of use on the northern subunits decreased considerably although the actual pellet count did not change. Subunit 8 received total (OVO) elk use much greater than availability (Fig. 7). Much of that subunit consists of westerly facing slopes at low elevations and is the only portion of the study area available to elk during most winters.

Topographic factors. Availability and elk use with respect to elevation, slope, aspect and topography are shown in Figs. 8 through 11. Spring and summer elk use within the study area was inappreciable below 5,000 feet (1,500 m). However, total use was slightly greater than availability, indicating those areas are primarily used during fall and winter. As discussed earlier, the significantly lower proportions of FN use below 5,600 feet (1,700 m) during summer 1977 was caused not by a decrease in the intensity of elk use, but was due to the increase in elk use above 5,600 feet (1,700 m).

Spring and summer elk use was significantly less than the availability of slopes in excess of 30°. The steepest slopes occur primarily at lower elevations and are used during fall and winter. The apparent selection of gentle (0-15°) slopes as opposed to moderate (16-30°) slopes during summer 1977 was not because elk preferred

Fig. 5. Summer 1976 fresh and new elk use.

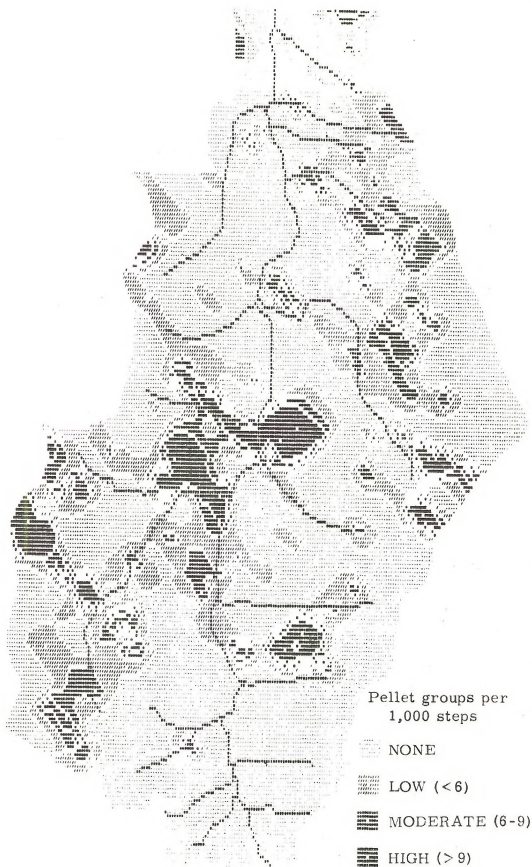


Fig. 6. Summer 1977 fresh and new elk use.

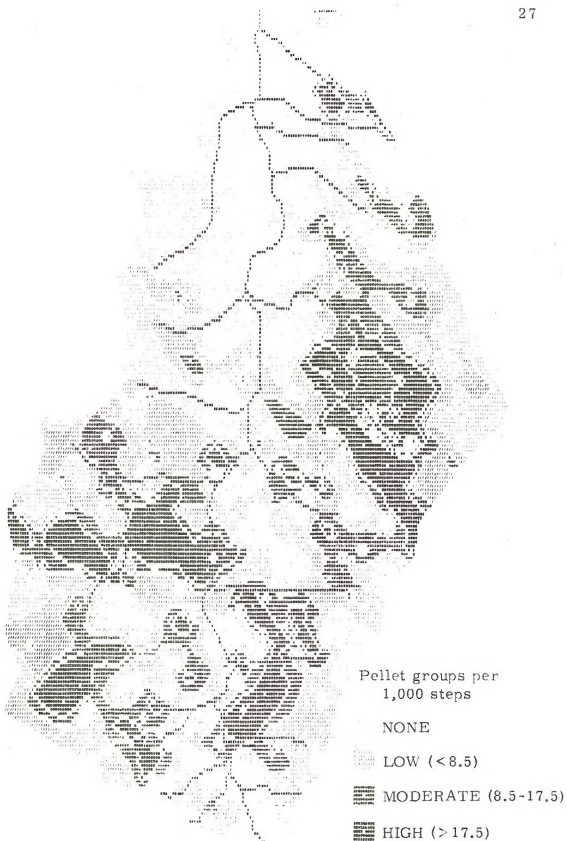


Fig. 7. Summer 1976 old and very old elk use.



Fig. 8. Percentages of availability and elk use by elevation.

Fig. 9. Percentages of availability and elk use by degrees slope.

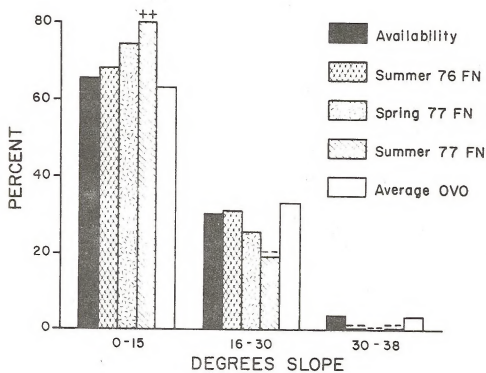
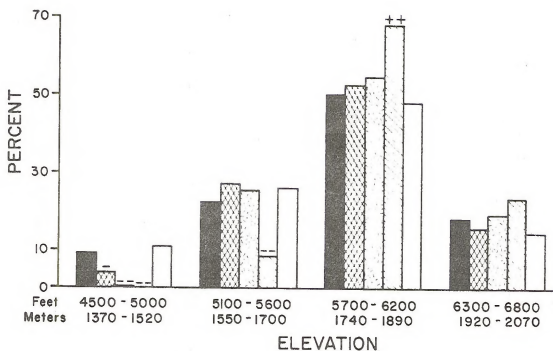
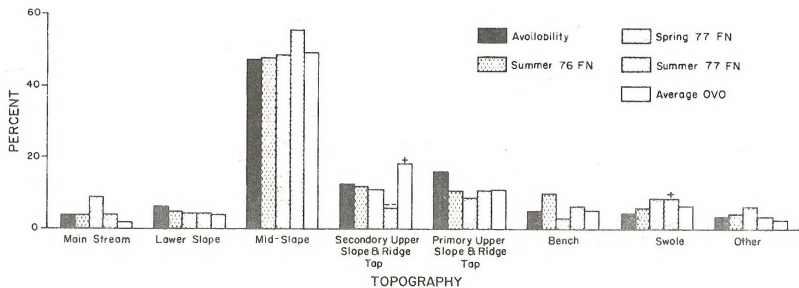
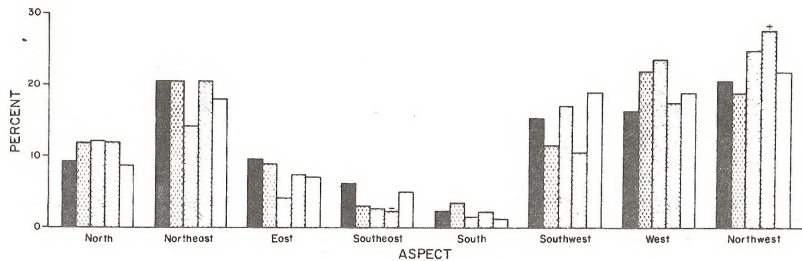
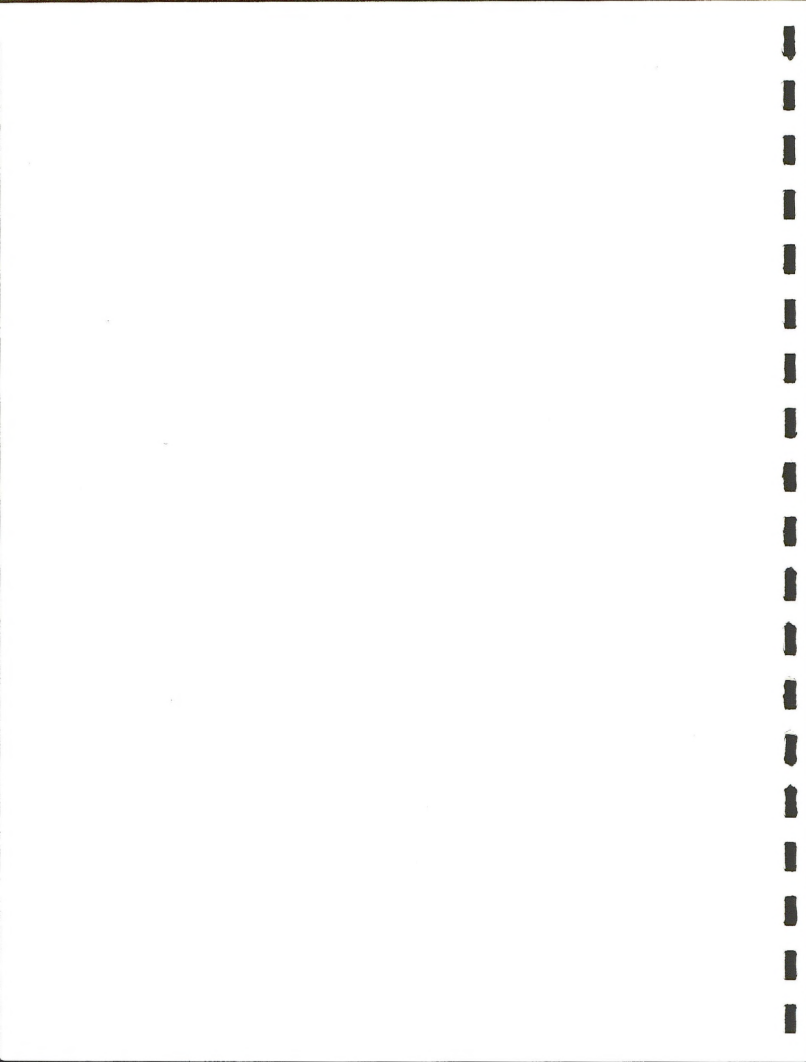


Fig. 10. Percentages of availability and elk use by aspect.

Fig. 11. Percentages of availability and elk use by topographic category.





the gentle slopes. Instead, the results merely reflect the preponderance of gentle slopes above 5,600 feet (1,700 m), the area used most intensively during July and August 1977. Elk did not appear to discriminate between gentle and moderate slopes within high or low elk use areas.

Elk did not exhibit a strong preference for nor avoidance of any particular aspect. West through north aspects were used slightly in excess of their availability during spring and summer and westerly aspects were somewhat preferred during fall and winter.

Although elk consistently preferred some topographic situations, topography does not appear to be an overriding influence in determining elk distribution within Chamberlain Creek drainage. Elk use on swales was always greater than availability. Benches at higher elevations were used in excess of their availability during July and August, probably because of the understory vegetation, mountain arnica and/or arrowleaf groundsel (Senecio triangularis). Lower slopes and primary upper slopes and ridgetops (ridges separating major drainages) were used less than their availability. Secondary upper slopes and ridgetops (ridges separating secondary streams within the main drainage) at lower elevations received significantly higher total elk use, primarily due to intensive fall and winter use of bunchgrass-pinegrass understory types. Elk avoided the main stream at the northern end of the study area, presumably because of steep



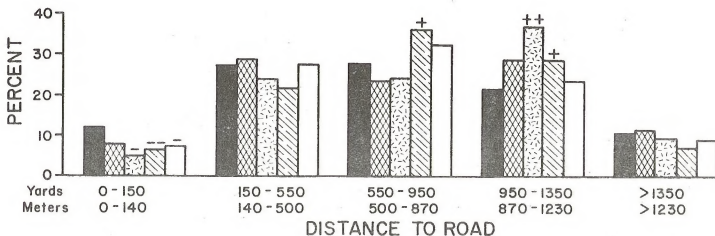
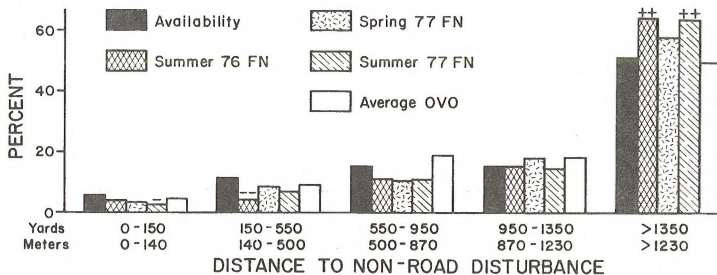
rocky slopes alongside the stream and very dense vegetation which rendered the stream bottom almost impassable. Fifty percent of the elk use occurred on mid-slopes. However, mid-slopes were neither selected for nor against.

Elk distribution in relation to roads and non-road disturbances (clearcuts or seed tree cuts) is shown in Figs. 12 and 13. Elk use within 550 yards (500 m) of a non-road disturbance was lower than availability while use at distances further than 550 yards (500 m) was generally greater than availability. This probably reflects the chance location of the disturbances in areas used lightly by elk, rather than an actual avoidance of areas near clearcuts. Use within the cuts was as high or higher than surrounding areas (Figs. 5, 6, and 7).

None of the roads bordering the study area had frequent vehicle traffic. In addition, all roads near or in the study area were closed to vehicle traffic from 1 September to 1 December. Despite this, elk use within 150 yards (137 m) of a road was significantly lower than availability. However, use was lower than availability only along the least-traveled section of road, the southern half of the "jeep" trail. That area is generally dominated by dense stands of lodgepole pine and alder thickets, a vegetation type which received light use in Chamberlain Creek. Use was at least equal to availability along more frequently traveled sections of road such as the northern end of the same "jeep" trail.

Fig. 12. Percentages of availability and elk use by distance to non-road disturbance.

Fig. 13. Percentages of availability and elk use by distance to road.



Ninety percent of the Chamberlain Creek study area was within one-quarter mile (400 m) of surface water. Therefore it is not surprising that distance to water did not markedly influence elk distribution (Fig. 14). In the northern third of the study area, elk use was light within 150 yards (137 m) of water probably due to steep slopes and dense vegetation adjacent to the main stream. Use was slightly greater than availability within 150 yards (137 m) of water in the southern two-thirds. Areas within 50 yards (46 m) of water were used more intensively during 1977 than during 1976. Elk use of areas further than 450 yards (410 m) from water was consistently and significantly lower than the availability of those areas.

Vegetative factors. Elk use and availability of overstory canopy cover, tree stand type, understory dominants, and habitat type are shown in Figs. 15 through 18. Areas of sparse overstory canopy (<25%) were used significantly in excess of their availability during May and June 1977 and during fall-winter. Elk use of segments with over 75 percent canopy cover tended to be low except for a shift to those types during July and August 1977.

Very dense stands of small lodgepole pine were generally used less than their availability. (Table 8 describes the approximate size classes and stem densities of each arbitrary tree stand type.) Use was also low in dense stands of mixed size subalpine fir and/or

Fig. 14. Percentages of availability and elk use by distance to water.

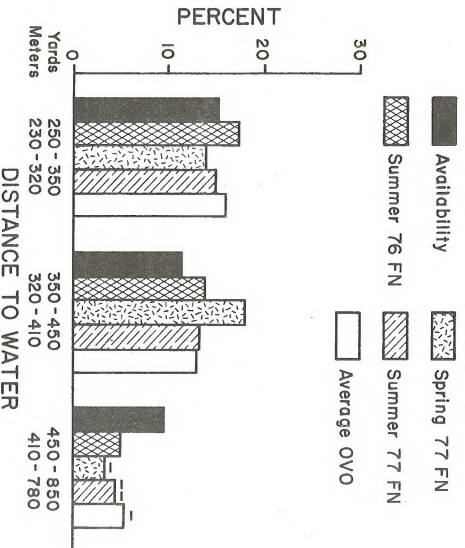
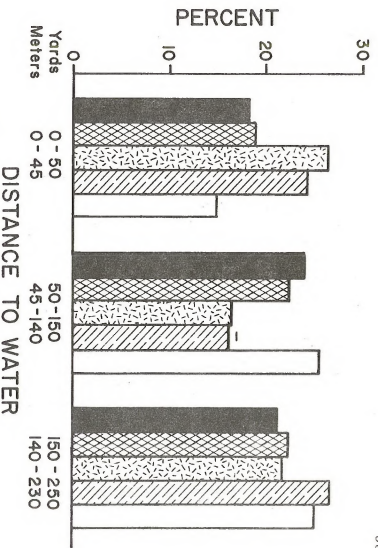


Fig. 15. Percentages of availability and elk use by percent overstory canopy cover.

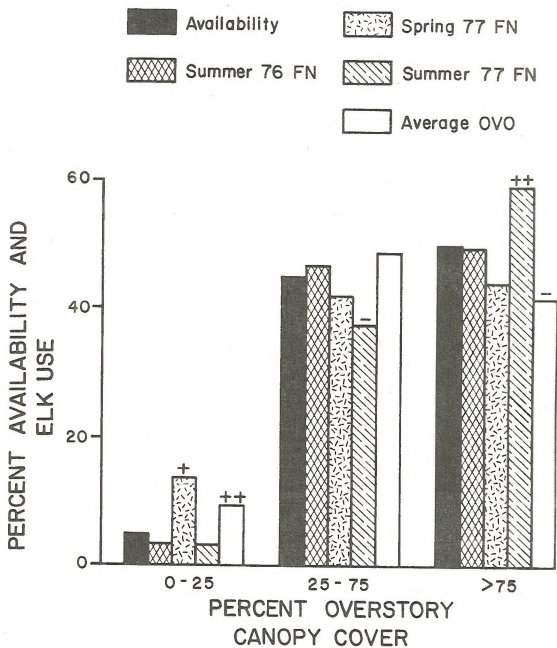
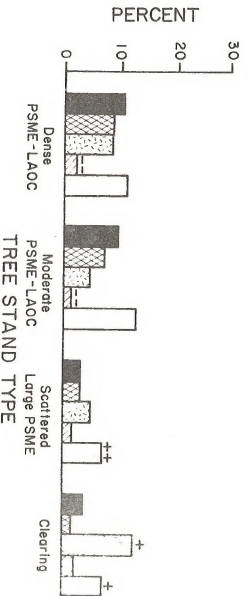


Fig. 16. Percentages of availability and elk use by tree stand type.



PSMC - *Pseudotsuga menziesii*
 ABLA - *Abies lasiocarpa*
 PICO - *Pinus contorta*
 LAOC - *Larix occidentalis*
 PIEN - *Picea engelmannii*

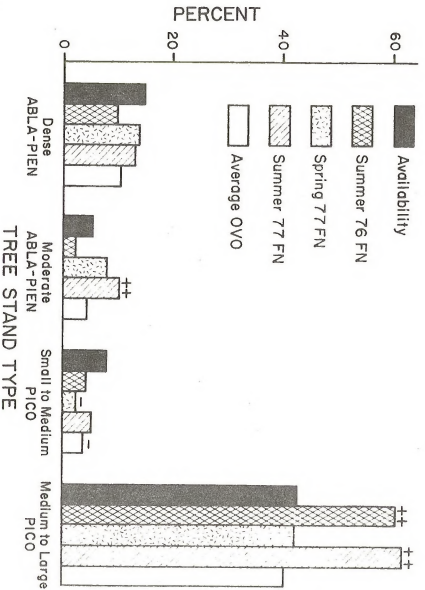


Fig. 17. Percentages of availability and elk use by dominant understory species.

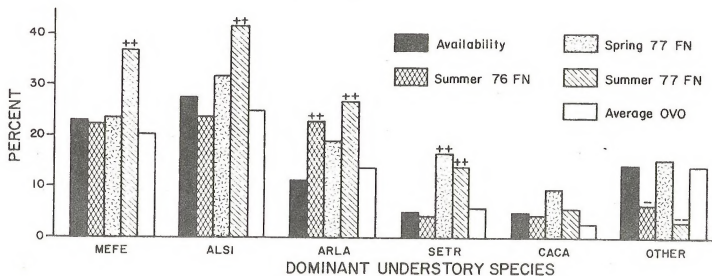
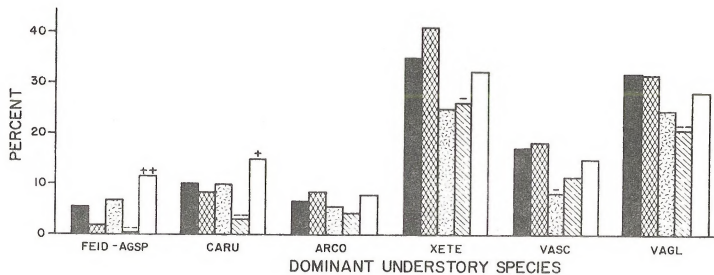


Fig. 18. Percentages of availability and elk use by habitat type.

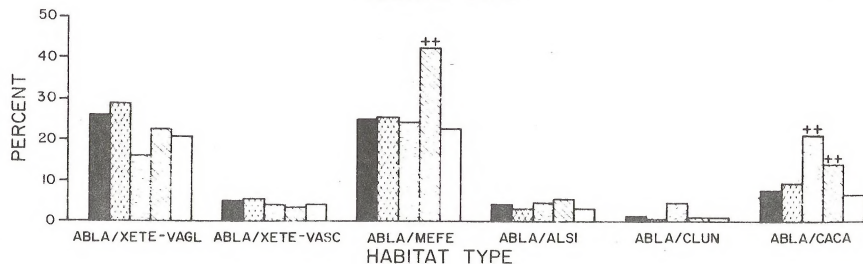
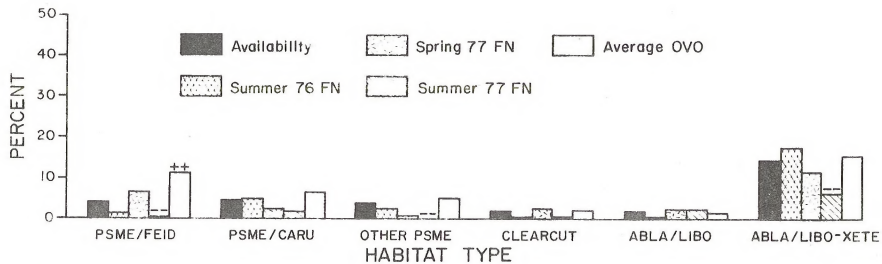




Table 8. Approximate size class and stem density of arbitrary tree stand types.

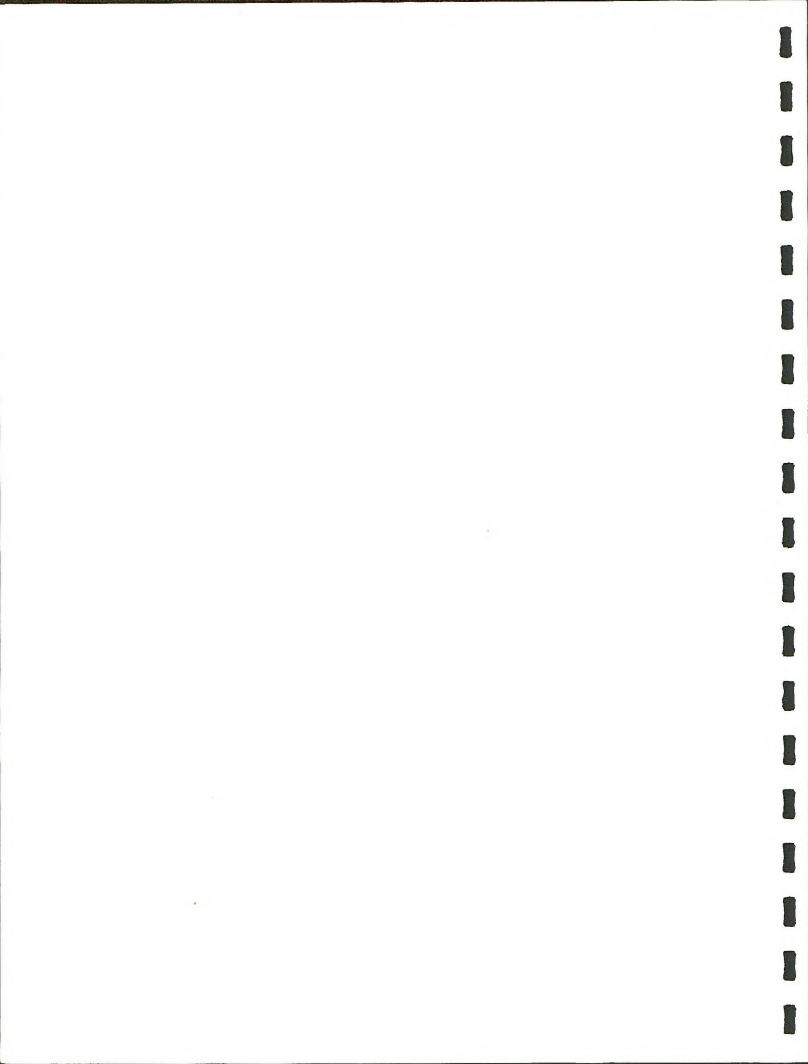
	Stems/acre	(Stems/ha)	dbH Size Class
Dense PSME-LAOC	200-400	(500-1,000)	all sizes
Moderate PSME-LAOC	40-200	(100-500)	mostly > 8 in. (20 cm)
Scattered Large PSME	< 100	(250)	> 8 in. (20 cm)
Clearing			
Dense ABLA-PIEN	200-400	(500-1,000)	all sizes
Moderate ABLA-PIEN	40-200	(100-500)	mostly > 8 in. (20 cm)
Small PICO	1,000-6,000	(2,500-12,000)	< 4 in. (10 cm)
Medium + Large PICO	200-800	(500-2,000)	4-8 in. (10-20 cm)



Douglas-fir. More open stands of Douglas-fir were used during fall and winter. Similarly open subalpine fir types were generally used slightly less than their availability but were the most intensively used type during July and August 1977. Despite the abundance of medium and large size lodgepole pine types in the Chamberlain Creek drainage, elk use during July and August was consistently greater than availability for all understory types within these stands. Clearings were used most during May and June and during fall and winter.

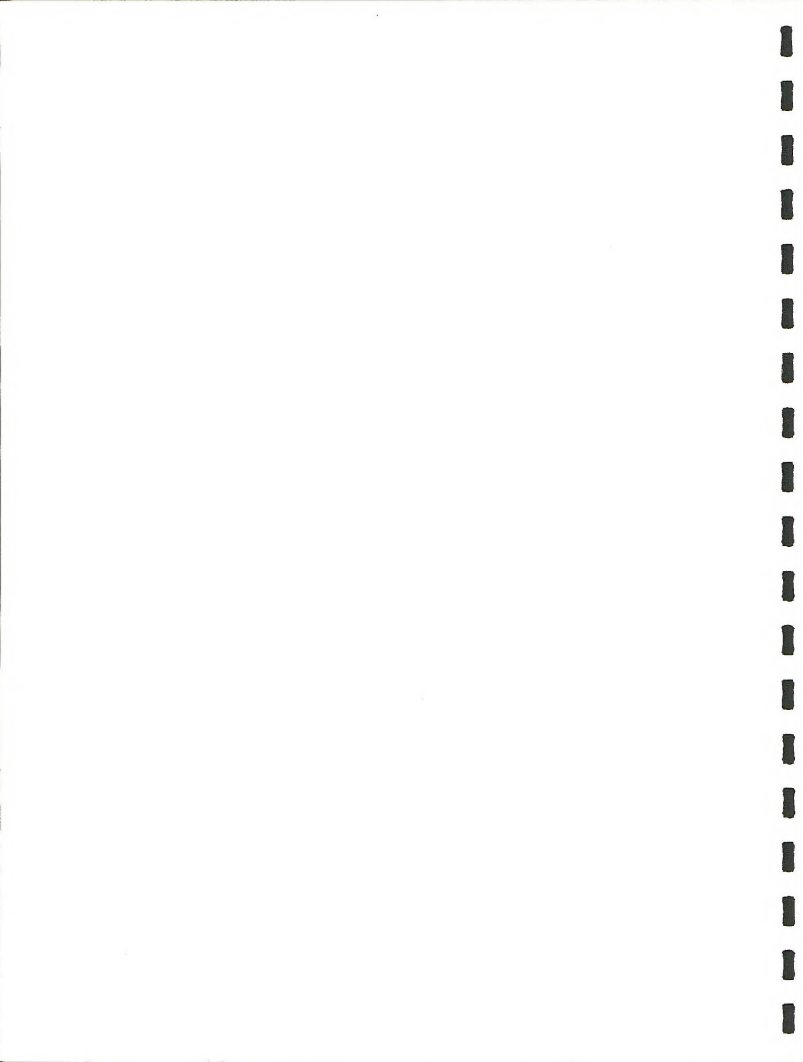
Fig. 17 represents the abundance of elk pellets in relation to the two most important understory species of each segment. Summer elk use appears low but fall and winter use is high on the more xeric understories such as pinegrass (CARU) and bunchgrasses (FEID-AGSP). The most preferred sites during May and June 1977 were the most xeric (bunchgrasses) and the most mesic understories; arrowleaf groundsel (SETR), mountain arnica (ARLA), and bluejoint reedgrass (Calamagrostis canadensis, CACA). Transect segments with mountain arnica in the understory were highly preferred during spring and summer. Similarly, heart-leaf arnica segments were selected compared to other types in the immediate area (the northern end of the study area). However, the use on heart-leaf arnica segments was not high compared to the entire study area.

Compared to 1976, the summer 1977 FN pellet count increased fivefold on mesic understories; arrowleaf groundsel,



bluejoint reedgrass, mountain arnica, fool's huckleberry (MEFE), and wavy-leaved alder (ALSI). The most intense use occurred on arrowleaf groundsel and mountain arnica segments. Although fool's huckleberry-alder stands were generally preferred sites, very dense alder thickets or alder stands associated with "doghair" lodgepole pine were not used. The FN count doubled on intermediate types such as beargrass (XETE), whortleberry (VASC), and globe huckleberry (VAGL) and remained the same on xeric types but the percent of FN elk use decreased because of the concentrated use on more moist types.

Elk use of habitat types was similar to that described for understory dominant species. The OVO pellet count was significantly greater than availability on Pseudotsuga menziesii/Festuca idahoensis types and slightly greater than availability of other P. menziesii types. The most preferred types during the spring were the most xeric (P. menziesii/Festuca idahoensis) and the most mesic (Abies lasiocarpa/Clintonia uniflora and A. lasiocarpa/Calamagrostis canadensis) within the study area. A. lasiocarpa/Menziesia ferruginea and A. lasiocarpa/Calamagrostis canadensis habitat types received the most intense use of all types during July and August 1977. The A. lasiocarpa/Alnus sinuata habitat types include only the most xeric portion of the spectrum of sites in which wavy-leaved alder occurs. Therefore, the A. lasiocarpa/Alnus sinuata habitat type does not show the heavy elk use which occurred during 1977 on segments dominated



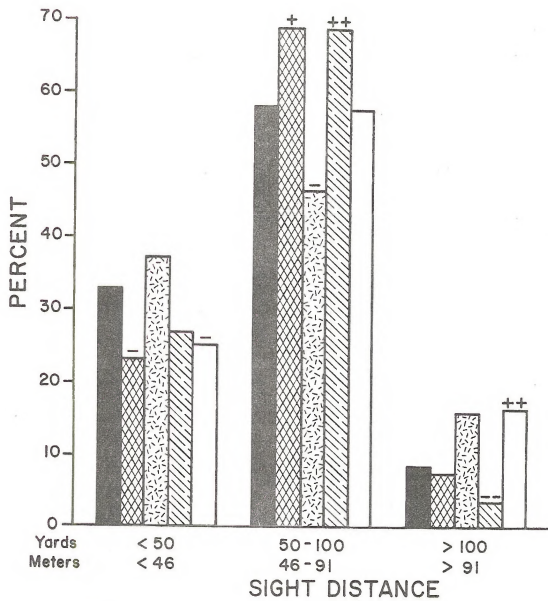
by alder.

The visual screening quality of vegetation under 6 feet (2 m) tall was recorded as the distance required to obscure an adult elk from a standing observer (sight distance). Sight distances under 50 yards (45 m) were used less than their availability except during May and June (Fig. 19). Stands of medium-to-large diameter lodgepole pine comprised most of the 50 to 100 yard (45-90 m) sight distances. The high elk use during July and August on areas with these sight distances reflects the preference for those lodgepole stands. Sight distances over 100 yards (90 m) occurred primarily in clearings or in mature Douglas-fir segments, which were used most intensively during fall through spring.

Availability and elk use of the relative stages of plant community maturity, based on climax trees, appear in Fig. 20. These successional stages (after Thomas et al. 1976) were defined as follows:

- Grass-Forb (recently disturbed)
- Brush-Seedling (only forbs, shrubs and tree seedlings occupy the site)
- Pole-Sapling (small trees)
- Young (dense stand of tall trees, usually seral species)
- Mature (seral trees mature, climax trees well developed as an understory)
- Old (climax trees mature and dominant, may be some seral trees remaining)

Fig. 19. Percentages of availability and elk use by sight distance.



Availability

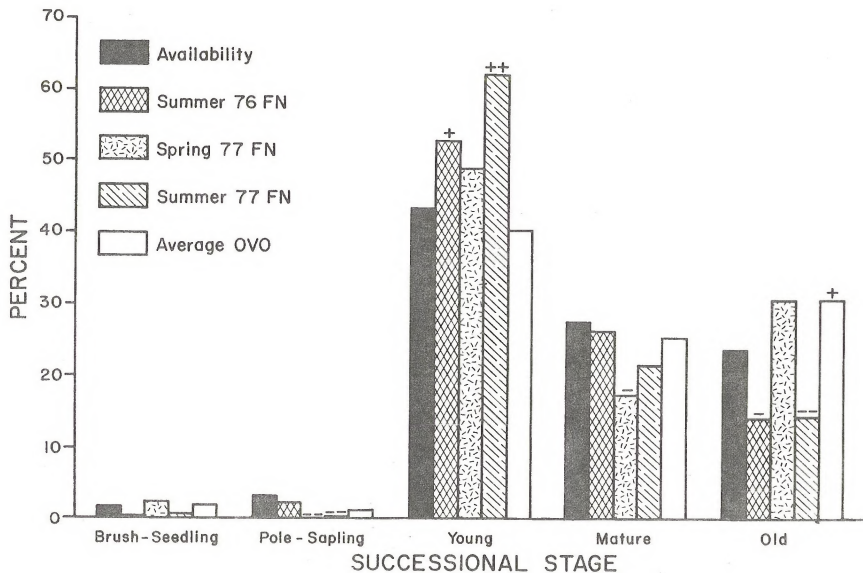
Spring 77 FN

Summer 76 FN

Summer 77 FN

Average OVO

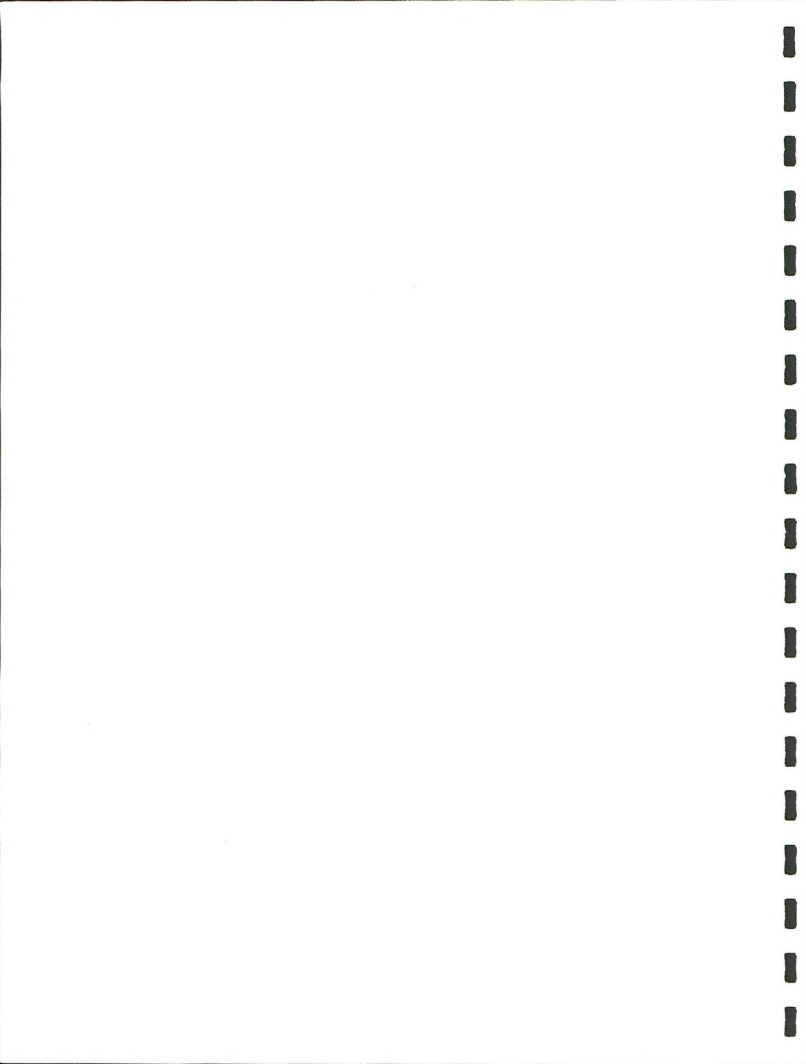
Fig. 20. Percentages of availability and elk use by successional stage.





Brush-seedling segments occurred only in the clearcuts at each end of the study area. The FN pellet count in the clearcuts was low during both summers but total elk use was approximately equal to availability. Total use was much greater than availability in the two small cuts at the southwestern corner of the study area. The pole-sapling successional stage corresponded with dense stands of small lodgepole pine, where elk use was consistently lower than availability. Seventy-three percent of the young successional stage was medium-to-large diameter lodgepole pine stands. The elk use pattern was very similar to that already discussed for those stands. As the plant community composition changed from young through mature to old stages, elk use during July and August decreased. Total elk use on old stands was significantly greater than availability, primarily due to spring and fall-winter use on more open Douglas-fir types.

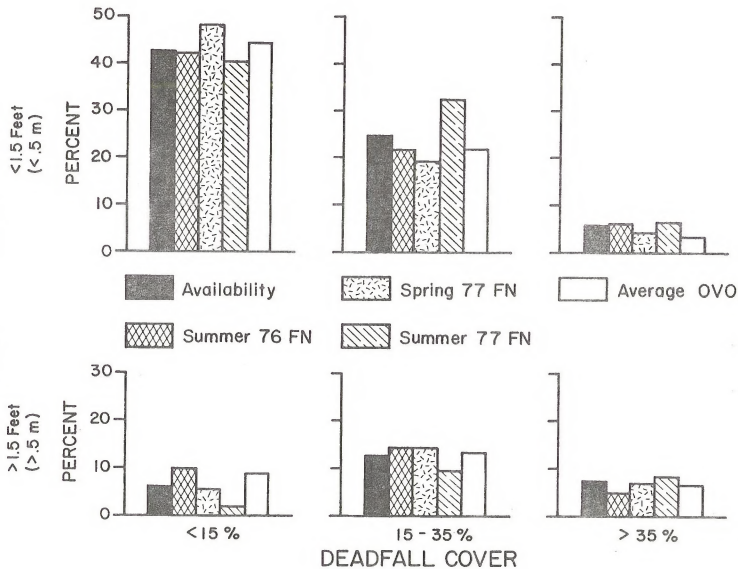
Few areas had significant amounts of deadfall. Only 10 segments had an average deadfall depth greater than 2.5 feet (0.75 m) and of those 10, only seven (1.8% of the total transect length) had more than 35 percent of the ground surface covered by deadfall. Within the deadfall levels found in Chamberlain Creek drainage, elk did not appear to select or avoid any class of deadfall

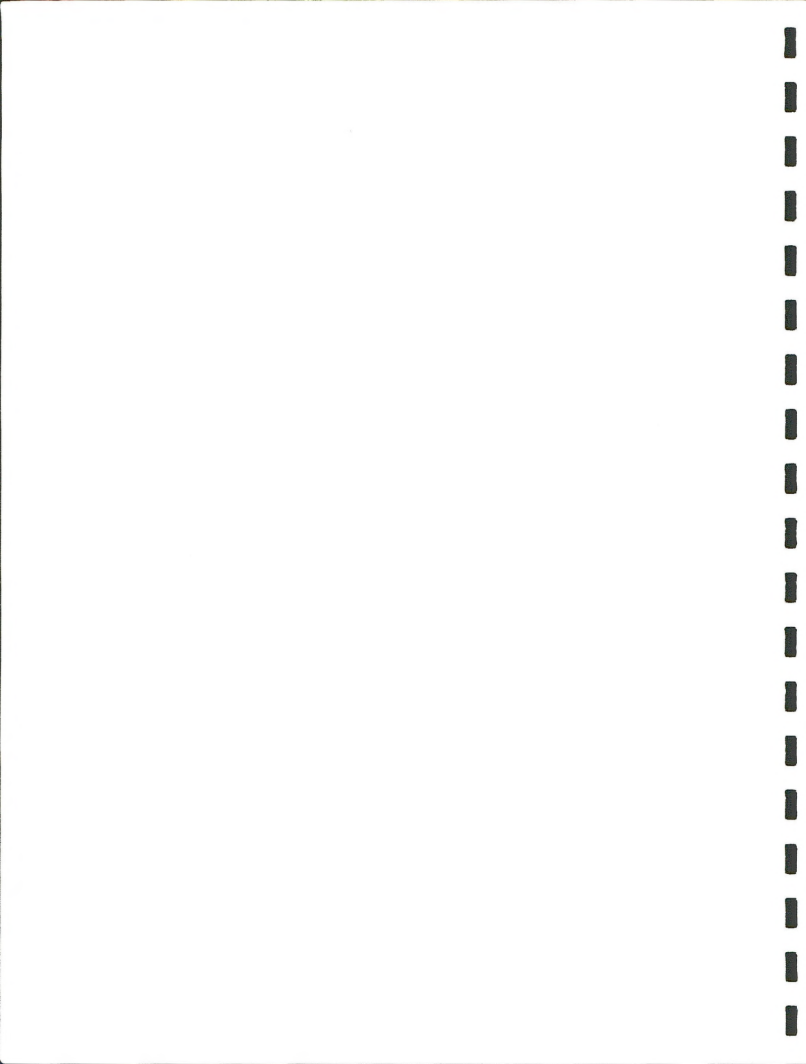


ground cover, deadfall depth, or any combination of depth and ground cover (Fig. 21).

Fig. 21. Percentages of availability and elk use by deadfall height and cover.

DEADFALL HEIGHT

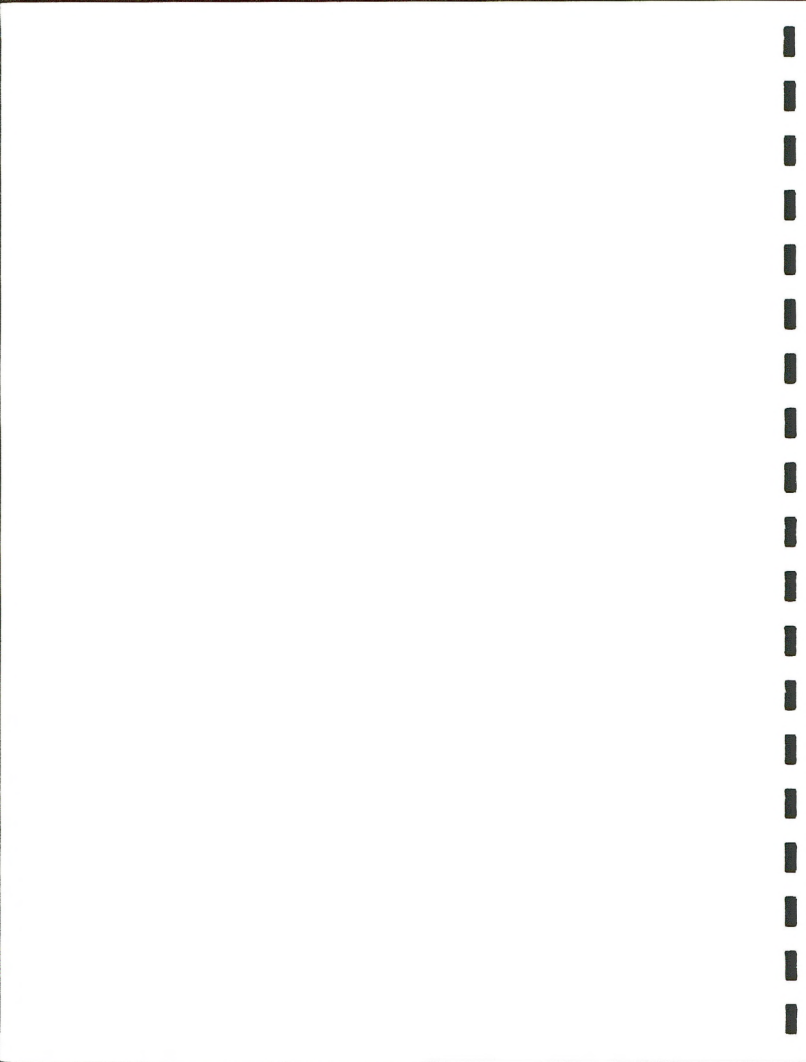




CHAPTER V

DISCUSSION

Cervid pellet group aging and decomposition has been studied primarily with deer pellets (Ferguson 1955, Robinette et al. 1958, Patric and Bernhardt 1960, Van Etten and Bennett 1965, Kufeld 1968). Most observers have reported a substantial carry-over of pellet groups from one year to the next. In a study in northern Utah, Low (1959, unpublished report, Utah Coop. Wildl. Research Unit, quoted by Neff 1968) found 93 percent of the deer pellet groups still recognizable after 3 years and 24 percent recognizable after 5 years. Patric and Bernhardt (1960) reported 62 percent of the white-tailed deer pellets in Adirondack coniferous forest types persisting at least 1 year. They could not reliably separate 18-month-old pellets from 6-month-old pellets based on pellet group appearance. In the upper peninsula of Michigan, Van Etten and Bennett (1965) found 53 percent of the white-tailed deer winter pellets still visible after 1 year, 26 percent after 2 years, and a few groups remained solid after 5 years. In Colorado, 89 percent of the deer pellets on a south slope winter range persisted for at least $10\frac{1}{2}$ months (Kufeld 1968). Lyon (1973) commented that there appeared to be a substantial year-to-year carry-over of elk



pellets in western Montana and that the ". . . disappearance of pellet groups is probably determined by an appropriate combination of weather factors at relatively infrequent intervals" (1976). Higher rates of pellet loss appear to be associated with either mechanical displacement of pellets by heavy washing rains (Wallmo et al. 1962) or with obscuration of groups by deciduous leaf fall (Patric and Bernhardt 1960, Van Etten and Bennett 1965). Neither is characteristic of the Chamberlain Creek area. Ferguson (1955) noted that deer pellets aged most quickly when not protected from the weather or shaded by vegetation. During the hot dry summer of Utah, unprotected pellets were bleached to gray or grayish-brown while groups on north slopes under dense cover were bleached very little or none at all. Van Etten and Bennett (1965) found that pellets on dry sites remained relatively unchanged for years while pellets on wet sites disappeared more quickly.

All pellet groups (including 16 initially VO groups) placed on pellet stations in Chamberlain Creek drainage persisted for at least 1 year and 90 percent were recognizable after 21 months. The decay rates may have been altered somewhat by transferring pellets from the original site of deposition. However, the sites selected for pellet stations were representative of most of Chamberlain. The steady accumulation of old pellet groups throughout the course of the study is consistent with Lyon's (1973) results, and indicates a substantial



carry-over of pellet groups from one count to the next. Seventy-six percent of the pellet groups painted during June 1977 were recounted in August 1977. Most of the remaining 24 percent was probably present, but not counted during August, or the paint mark had become obscured. Ferguson (1955), however, in an area with cold, snowy winters and hot, dry summers, reported that "Pellet groups are preserved in excellent condition during the winter and early spring," and that most of the weathering occurred during the summer.

Pellet groups did not predictably age from fresh through new and old to very old within a given time interval. All FN pellet groups aged to OVO within 2 months during the summer. Apparently some groups deposited after the spring 1977 count aged to OVO before the summer 1977 count. Probably, pellets deposited under sparse over-story canopies on south and west aspects or in natural clearings or clearcuts were desiccated more quickly and hence appeared older than similar-age pellets deposited under dense forest canopies. Therefore, the pellet counts probably underestimated elk use of exposed sites during July and August. Use of wet meadows appears to have been also underestimated by pellet counts. Although other elk sign (trails, beds, and wallows) was evident in the meadows, the pellet count was not high. Pellet counting in wet meadows was hindered by dense vegetation often combined with 1 or 2 inches (2 to 5 cm) of standing water, both of which presumably accelerated pellet group deterioration.



Old pellet groups tended to remain in that age category indefinitely. No particular season of use could be identified with OVO pellet groups. However, fall and winter use could be inferred in areas with low spring and summer FN pellet counts but high OVO pellet counts. In other areas, it is difficult to separate fall and winter elk use from previous years' accumulation of spring and summer pellets. Telemetry data indicate little elk use of higher elevations in the study area during fall and winter (Marcum et al. 1978). For this study, the FN pellets were interpreted to represent approximately the previous 2 months of elk use. OVO groups were of indeterminate age and more nearly represented total yearly elk use rather than a particular season of elk use.

Observer bias entered the pellet count in several ways. There appeared to be some inconsistency among observers in distinguishing fresh pellets from new pellets and old from very old pellets. This inconsistency was resolved by combining fresh with new and old with very old pellets during the analysis. Inconsistencies probably also existed among observers in identifying marginal groups as inside or outside the belt, in identifying the number of groups present in high pellet density areas or in the case of scattered pellets, and in the thoroughness with which observers searched for pellet groups. Nevertheless, the inconsistencies should average out when several or more segments counted by different observers are combined to provide the

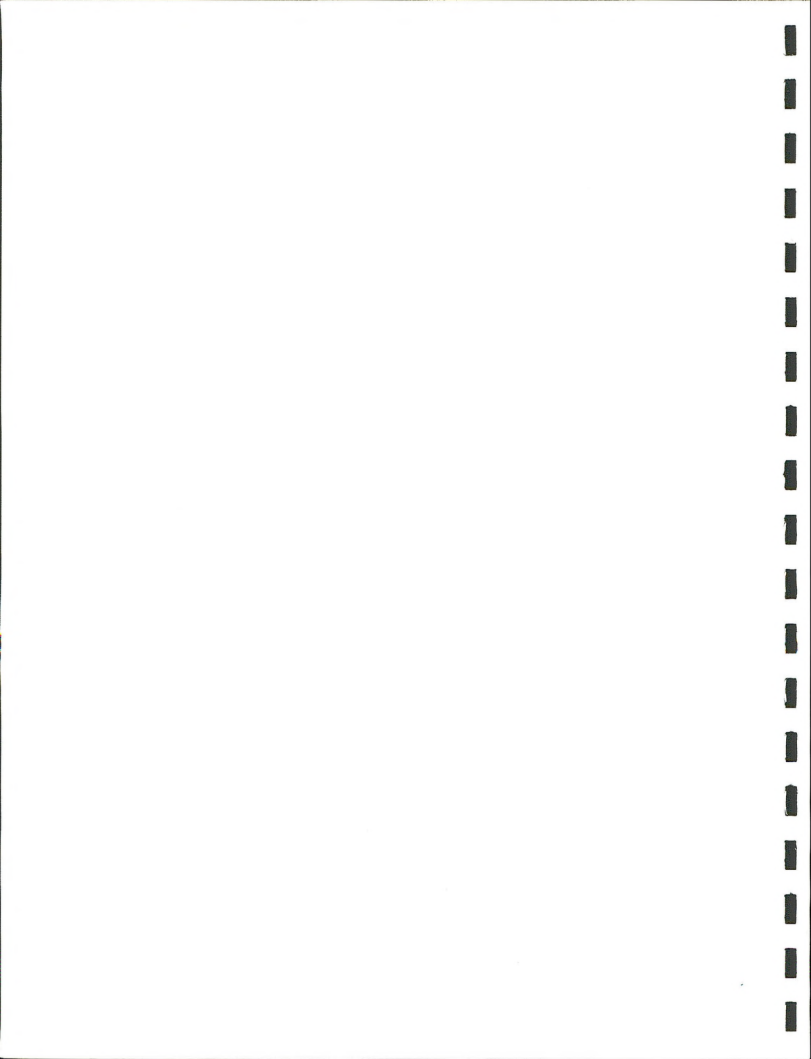


results for one level of a variable. In the one instance when a strong observer bias was identified, a wide range of possible correction factors was tested and was found to make only slight changes in the results.

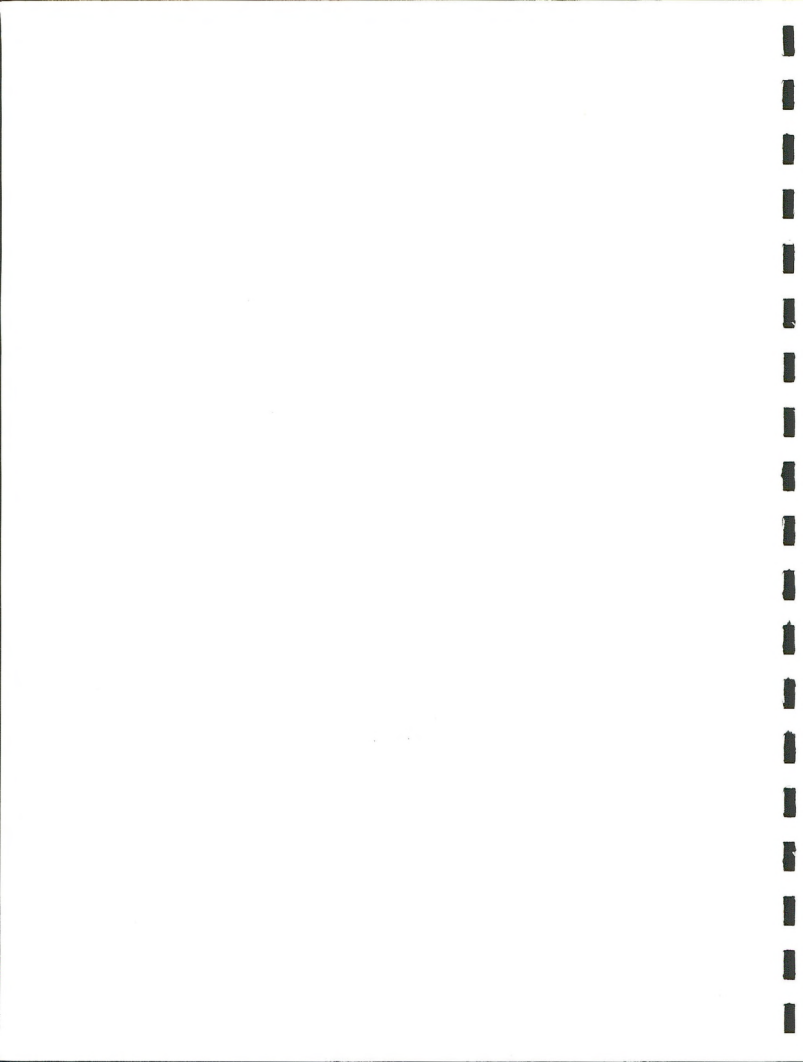
Pellet count data indicate that virtually all available habitats in Chamberlain Creek drainage are used by elk at one time or another. Julander and Jeffery (1964), Biggins (1975), and Marcum (1975) similarly noted the wide range of habitats used by elk on the summer range. Elk appear to become much more selective during periods of stress. The winter and spring of 1977 were exceptionally dry, which presumably led to lower forage production and earlier forage desiccation on most of the spring and summer range. Although partially a function of sample size differences, 46 habitat attributes were used significantly different than their availability during July and August 1977 in contrast to only 12 such differences during summer 1976. No environmental situation was preferred during all seasons of the year. However, some situations were consistently avoided. Use was always lower than availability on slopes in excess of 30°, primary upper slopes and ridgetops, dense stands of small lodgepole pine (pole-sapling successional stage), and areas further than 450 yards (410 m) from water. Seasonal habitat use patterns are discernible and they appear to be influenced primarily by vegetation structure, composition, and phenology.



Spring and summer elk use tends to occur on northwesterly aspects above 5,000 feet (1,500 m) elevation. Fall use is more intense on southwesterly aspects below 5,600 feet (1,700 m) and winter use is concentrated on southwest and west exposures below 5,000 feet (1,500 m). Steep slopes (in excess of 30°) were avoided in Chamberlain, particularly during spring and summer. Moderate slopes were used in proportion to their availability and gentle slope use was slightly greater than availability. Marcum (1975) and Biggins (1975) also reported an elk preference for gentle slopes and avoidance of steep slopes during summer and fall. Few topographic categories were used significantly different than their availability. Mid-slopes are generally used in proportion to their availability during the summer (Biggins 1975, Lonner 1975). Marcum (1975) reported significantly lower use on mid-slopes but this may reflect the generally steep nature of mid-slopes in his study area and differences in classifying slope position. During my study, most of the elk use occurred on mid-slopes but mid-slopes were neither selected for nor against. Ellison et al. (1972) found the most intense elk use on mid-slopes in upper Chamberlain Creek drainage. However, their mid-slope category was apparently very general, including all areas not classified as drainage bottom or ridge top. I found that some specific topographic situations located on mid-slopes, such as swales, benches, and small "finger" ridges, were preferred sites during July and August,



apparently because such sites often support more succulent vegetation than surrounding areas. Joslin (1975) observed heavy elk use of benches and flat areas during summer and fall. Lonner (1975) found high summer use of benches and swales but use shifted away from these types during the fall. Elk use of upper slopes and/or ridgetops has generally been reported as low during the summer (Ellison et al. 1972, Zahn 1974, Biggins 1975, Lonner 1975). Upper slopes and ridgetops were used less than their availability in Chamberlain, with the exception of highly preferred secondary upper slopes and ridgetops during fall-winter. Primary upper slopes and ridgetops often had thin rocky soils which produced poor cover and forage except in moist areas. Julander and Jeffery (1964) and Marcum (1975) noted heavy use of upper slopes but not ridgetops. In Marcum's study area, the upper slopes tended to be more gentle than the steep mid-slopes, which probably influenced elk distribution. In addition, his classification system would likely have included much of Chamberlain as upper slope, therefore his results may not be directly comparable to mine. Elk may also make heavier use of upper slopes during winter and early spring, apparently in response to snow depths and thermal conditions (Beall 1974, Biggins 1975). Lower slopes appear to be avoided during summer and fall in Chamberlain as well as other areas (Julander and Jeffery 1964, Biggins 1975, Joslin 1975, Lonner 1975, Marcum 1975) but lower slopes may receive more use during winter



and early spring (Biggins 1975). The attractiveness of drainage bottoms appears to reflect the relative abundance of preferred forage species compared to surrounding areas, the accessibility of the drainage bottoms, and perhaps the presence or absence of cattle. Lonner (1975) found the use of drainage bottoms to be significantly below average during summer and fall in an area where cattle grazed and succulent forage was readily available in wet meadows. Marcum (1975) and Zahn (1974), in areas where moist sites were less abundant, both reported significant summer-fall use of drainage bottoms. Cattle did not graze the Chamberlain study area and moist sites were relatively abundant. The only apparent influence of stream bottoms on elk distribution was an avoidance of those areas along streams where elk movement was inhibited by steep, rocky slopes and dense shrubby vegetation.

Elk in the Sapphire Mountains avoided areas within 550 yards (500 m) of clearcuts and preferred areas 550 to 1,750 yards (500-1,600 m) away (Marcum 1975). In the Chamberlain study area, use was slightly less than the availability of areas within 950 yards (870 m) of a clearcut and was significantly greater at distances in excess of 1,350 yards (1,230 m). However, this probably reflects the chance location of the clearcuts in areas lightly used by elk rather than an actual avoidance of clearcuts and the areas near them.

Data from several studies indicate that areas within $\frac{1}{4}$ mile



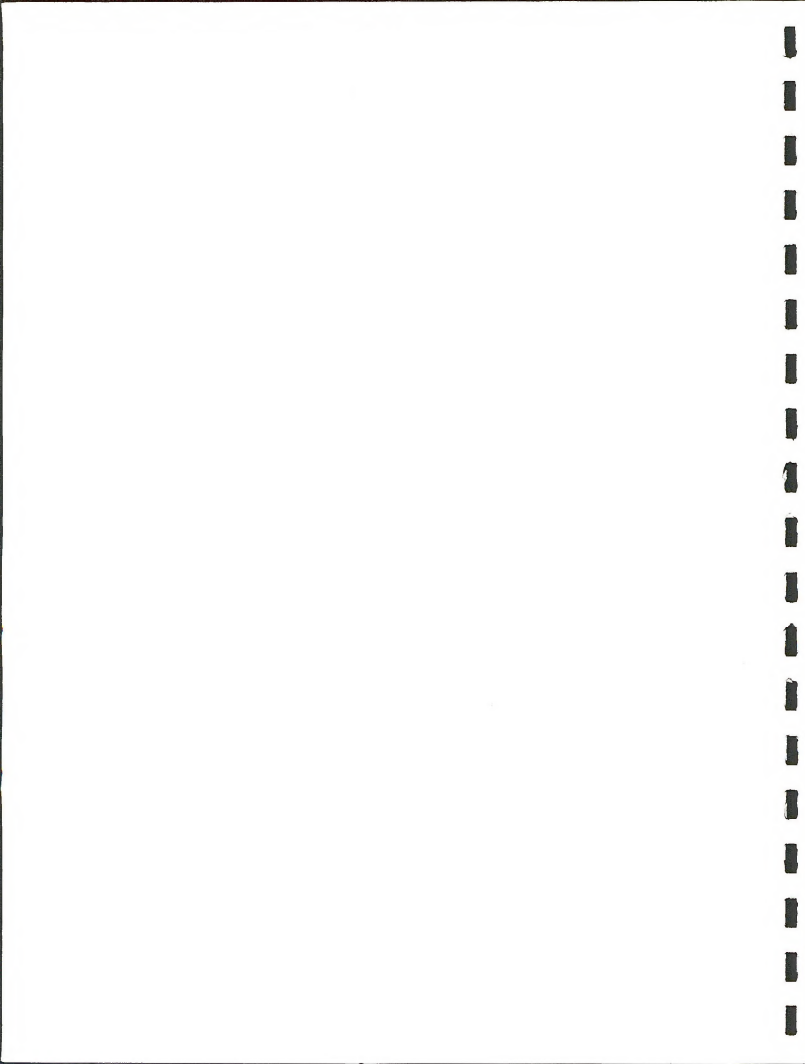
(400 m) of a road tend to be avoided by elk (Lyon 1974, Marcum 1975, Burbridge and Neff 1976, Hershey and Leege 1976, Perry and Overly 1976). Ellison (1974) reported little or no elk use within 200 feet (61 m) of the upper Chamberlain jeep trail except in areas which were screened by vegetation or topography. Maximum use occurred at approximately $\frac{1}{4}$ mile (400 m) from the road. My study indicated a similar aversion to the same section of jeep trail. However, I feel that the low use along the road is a response to topographic (primary ridgetop) and vegetative (dense lodgepole pine and/or very dense alder thickets) features rather than a reaction to the road itself. The jeep trail is closed to vehicular traffic from 1 September to 1 December, is impassable (except to snowmobiles) until at least early May, and receives only light vehicular traffic during the summer. Lonner (1977) stated that elk use increased as distance from a new road increased but added ". . . there was a natural aversion toward the sale area during the summer season before any logging activity began and that logging activity thus far has not significantly influenced the little use that occurred previously." It is important to note that the condition of the road, which influences both the amount and speed of vehicular traffic, and the vegetative cover surrounding the road influence elk response. Marcum (1975) found that while open system roads depressed elk use out to 550 yards (500 m), open spur and four-wheel drive trails did not significantly affect elk use and elk selected



for closed roads. In the Blue Mountains, primitive roads only slightly disrupted elk use of meadows and open forests (Perry and Overly 1976). In dense forests, the highest use along primitive roads was immediately adjacent to the road. Burbridge and Neff (1976), however, felt that infrequent, slow, noisy traffic along primitive roads was more disturbing than constant rapid traffic on an asphalt highway.

Julander and Jeffery (1964) and Lyon (1974) reported little relationship between distance to water and elk distribution in areas where water was relatively abundant. However, where water is less common, elk use appears to be depressed in areas far from water (Mackie 1970, Marcum 1975). Water is abundant in the Chamberlain Creek drainage; 90 percent of the study area is within $\frac{1}{4}$ mile (400 m) of water and is used by elk in proportion to availability. Elk use was less than the availability of areas further than 450 yards (410 m) from water. This is partially because of the predominance of ridgetops in the over 450 yard (410 m) category. Nevertheless, ridgetops within 450 yards (410 m) were used more heavily than ridgetops further than 450 yards (410 m) from water. This relationship also appears true for all tree stand types and understory types.

In Chamberlain Creek drainage, elk preferred open overstory canopies (<25%) during spring and again during fall-winter. Most observers have reported high elk use of heavily timbered areas during



the fall, particularly during the rut (Hash 1973, Bohne 1974, Simmons 1974, Biggins 1975, Lemke 1975, Lonner 1975). Marcum (1975) found light to moderately (1-75%) timbered areas to be most heavily used by cow elk during October and November. However, that does not necessarily imply the animals were not in dense cover. Many of the locations were in shrubby areas where horizontal visibility was limited (C. L. Marcum 1978, pers. comm.). Winter use in the lower Chamberlain drainage does appear to be concentrated on more open southwesterly exposures but it's not clear whether open areas are also selected during the fall. Elk use of moderate and closed overstory canopies during July and August 1976 was very near the availability of those types. During summer 1977 (a dry year), elk preferred areas with greater than 75 percent canopy closure. Zahn (1974) found 70 percent of his Burdette Creek-Deer Creek radiolocations during July and August in stands with closed canopies ($> 60\%$). Similar work by Lemke (1975) in the same area resulted in only 39 percent of locations under canopies exceeding 60 percent. However, Lemke apparently grouped visual observations and radiolocations together, which may have biased the data toward more open timber stands. Pellet counts in Burdette Creek-Deer Creek revealed a slight preference for overstory canopies under 25 percent and canopies exceeding 75 percent (Lyon 1974). Marcum (1975) reported a preference for 26-75 percent canopy cover during summer and fall of 2 dry years and a preference



for 1-25 percent cover during a wet year. He further added that "Open and lightly timbered areas were preferred for feeding . . . and heavily timbered areas were used most for bedding." Joslin (1975) noted that bedding sites occurred under 25-50 percent canopy cover but feeding sites always occurred under less than 25 percent cover. Summer elk use of open understories was probably underestimated by the Chamberlain pellet counts because of rapid aging of exposed pellet groups.

Chamberlain elk exhibited a strong seasonal pattern in relation to different tree stand types. Stands of medium to large size lodgepole pine were highly preferred during both summers. In addition, the more mature, open stands of subalpine fir-Engelmann spruce were heavily used during May through August 1977. During the fall and winter, elk use shifted away from lodgepole pine toward Douglas-fir-western larch stands, particularly to very open stands of large Douglas-fir. Clearings were used in excess of their availability during winter and spring. The spring use of clearings probably reflects the earlier development of forage vegetation in exposed situations. The preference appeared to be more for the clearings themselves than any particular understory vegetation type. With the exception of grouse whortleberry, the use of clearings of a given vegetation type was four to eight times greater than the use of non-clearings with the same dominant understory species. Dense stands of young subalpine fir-Engelmann spruce



or lodgepole pine were usually avoided during all seasons. Lyon (1974) found that elk preferred Douglas-fir and ponderosa pine stands with less than 25 percent overstory canopy during the winter. Douglas-fir stands were not selected during the summer but "... lodgepole pine in dense canopy [$>75\%$] is selected as a preferred cover." Other Montana studies have indicated a summer shift in elk use to the spruce-fir zone (Kirsch 1962, Stevens 1966, Biggins 1975, Lemke 1975). In the Long Tom drainage east of the continental divide, the highest summer elk use was associated with moist parks within the spruce-fir zone (Lonner 1975).

Successional stage and sight distance were closely related to tree stand type and therefore exhibit similar elk use patterns. The pole-sapling successional stage had sight distances of less than 50 yards (46 m) and was composed of dense stands of "doghair" lodgepole pine, a type consistently avoided by elk. Stands of medium to large size lodgepole pine were usually classified as young successional stage and had sight distances of 50-100 yards (46-91 m). Again, these stands were highly preferred during the summer. The mature successional stage appears to consist about equally of subalpine fir-Engelmann spruce, Douglas-fir-western larch, and mature lodgepole pine stands. Sight distances less than 50 yards (46 m) (because of dense tree regeneration and/or high shrub density) and 50-100 yards (46-91 m) are both common. Apparently the contradictory seasonal trends in elk



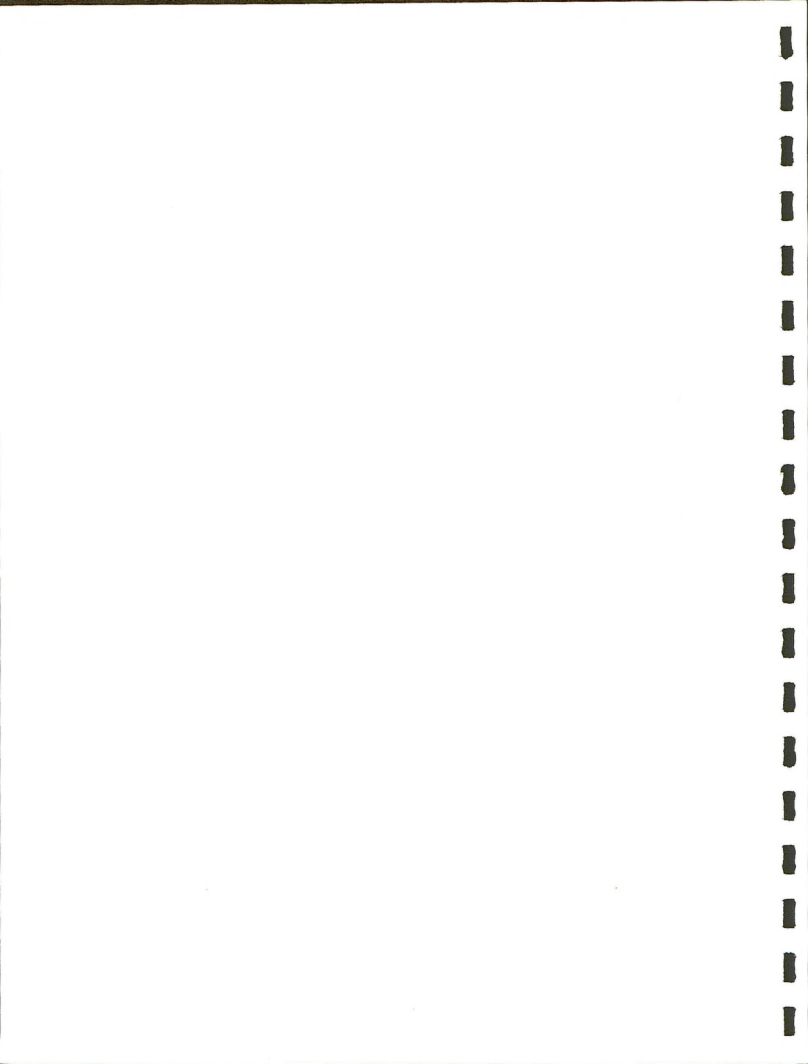
use within the different tree stand types combine to keep elk use at or below the availability of mature successional stages. Sight distances in excess of 100 yards (91 m) were associated with clearings and more open stands of mature Douglas-fir and were usually classified as old successional stage. These types received primarily winter and spring elk use. Lemke (1975) reported that 82 and 95 percent of his summer and fall locations were in tree stands with heights of 35-100 feet (11-30 m) and 0 and 3 percent, respectively, were in stands taller than 100 feet (30 m). In contrast, 32 percent of the spring locations were in stands taller than 100 feet (30 m) while only 10 percent occurred in the 35-100 foot (11-30 m) category. This seems to coincide with the use patterns of old and young successional stages in Chamberlain. Lonner (1976) could find little relationship between elk use and alpine fir regeneration density during the summer but did find a significant positive correlation between elk use and stand age during the fall (younger stands were lodgepole pine while older stands were alpine fir, Engelmann spruce and lodgepole pine with dense regeneration of alpine fir). Lonner (1976, 1977) also reported an increasing trend in summer elk use with sight distances up to 250 feet (76 m), at which point use decreased slightly. This appears to be similar to the pattern in Chamberlain.

The majority of food habits studies indicate that forbs are a very important component of the elk summer diet. Joslin (1975) stated:



"... it appeared that elk were selecting sites with regard to forbs."

In Chamberlain, the most preferred sites during the summer were those with an understory dominated by mountain arnica. Grazed arnica plants were frequently seen, particularly in moist areas. During 1977, a dry year, the preference for arnica types became even more apparent and included the other moist forb type (arrowleaf groundsel). In addition, areas dominated by fool's huckleberry and wavy-leaved alder were also selected during summer 1977. Although Young and Robinette (1939) and White (1960) reported heavy browsing on fool's huckleberry in some areas, I saw only very occasional use of either shrub in Chamberlain. Within the Abies lasiocarpa/Menziesia ferruginea habitat type in the Sapphire Mountains, fool's huckleberry was browsed but was not a preferred species (Marcum 1975). The most important species within this habitat type was mountain arnica. Ground observations of radio-collared animals in the Chamberlain study area during July and August 1977 revealed a predictable daily pattern of elk use related to fool's huckleberry-alder types. During the early morning and evening, elk fed into the clearcuts at the southern end of the study area or into mature lodgepole pine stands with a dense understory of mountain arnica. Most of the daylight hours were then spent bedded in fool's huckleberry-alder thickets within relatively dense stands of medium to large size lodgepole pine. The fool's huckleberry-alder types were frequently interspersed with moist



stringers of succulent forbs. Apparently these combinations of cover and forage were very attractive to elk during the summer, particularly during 1977. The most xeric understories (bunchgrasses) receive little summer elk use during a year with normal precipitation but substantial use occurs on intermediate types (beargrass, grouse whortleberry, globe huckleberry) in proportion to their availability. During 1977, the use of intermediate types increased but the increase was masked by the relatively much greater increase in the use of fool's huckleberry-alder and arnica types. Idaho fescue-bluebunch wheatgrass and pinegrass understories were preferred only during the fall and/or winter months. Because of snow depths, these types were the only ones likely to be available to elk during the winter and early spring.

Elk use of habitat types was similar to that described for understory dominants though the pattern was less apparent. Considerable variation in vegetative structure and composition occurs within a given habitat type or phase, thus habitat type is rather an imperfect measure of the habitat attributes influencing elk distribution. During what was considered a typical weather year, summer elk use was not significantly different than the availability of any habitat type.

Pseudotsuga menziesii types were used slightly less than their availability while Abies lasiocarpa types were used slightly more. During a dry year, elk preferred moist habitat types (Abies lasiocarpa /



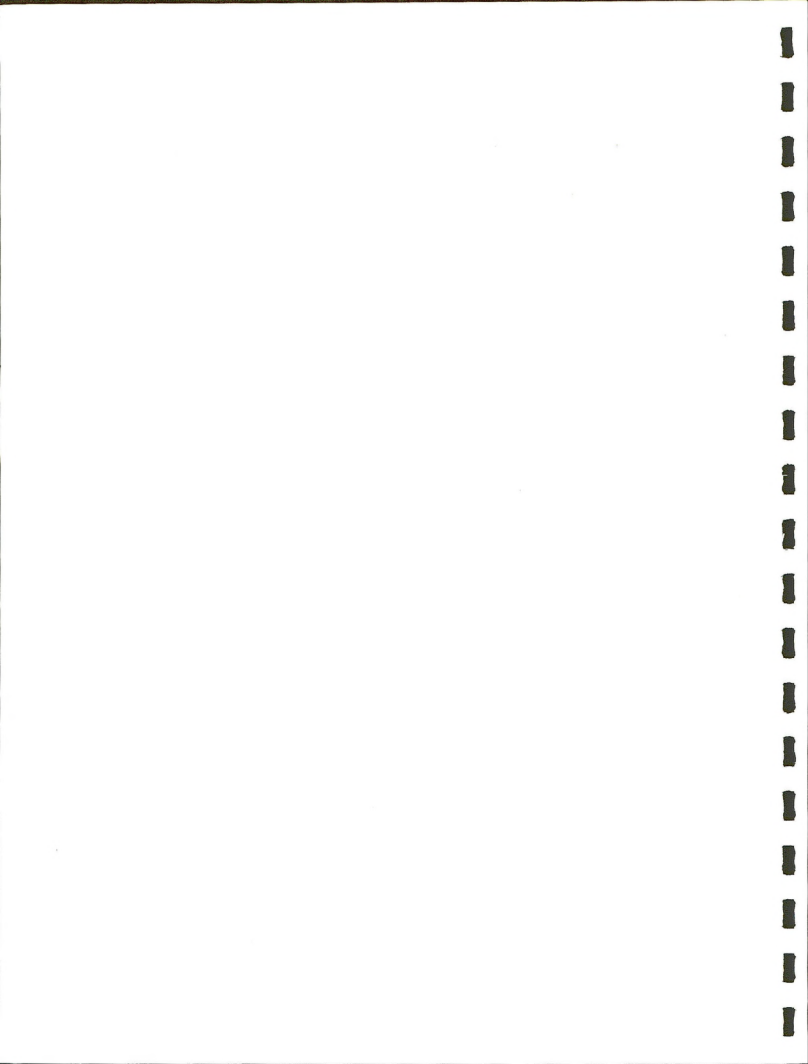
Menziesia ferruginea, Abies lasiocarpa/Clintonia uniflora, and Abies lasiocarpa/Calamagrostis canadensis) during spring and summer.

Marcum (1975) also noted a tendency for elk to use xeric types in cool, wet years and more mesic and hydric types during warm, dry years. Pseudotsuga menziesii types were favored during fall and winter, particularly Pseudotsuga menziesii/Festuca idahoensis, which may have been the only type available within the study area during winter.

Several observers have noted the importance of yearly and seasonal weather fluctuations in determining elk habitat use (Mackie 1970, Bohne 1974, Marcum 1975, Burbridge and Neff 1976, Lonner 1977, Lyon 1978). Precipitation was near-normal during 1976, much below normal during winter and spring 1977, and above average during July 1977. Most of the winter and spring range for Chamberlain elk is below 5,000 feet (1,500 m) on south and west-facing slopes. Overstory canopy is generally rather open, either naturally or as a result of timber harvest. It seems likely that forage production was lower than usual on these slopes during 1977 and that desiccation occurred earlier. The upper Chamberlain Creek drainage, with its northerly slopes and dense overstory canopy, retained succulent forage, primarily forbs, throughout the summer. Apparently, elk were attracted into upper Chamberlain earlier than usual and were more likely to remain in the area than during other years. The FN pellet count went from 201 in

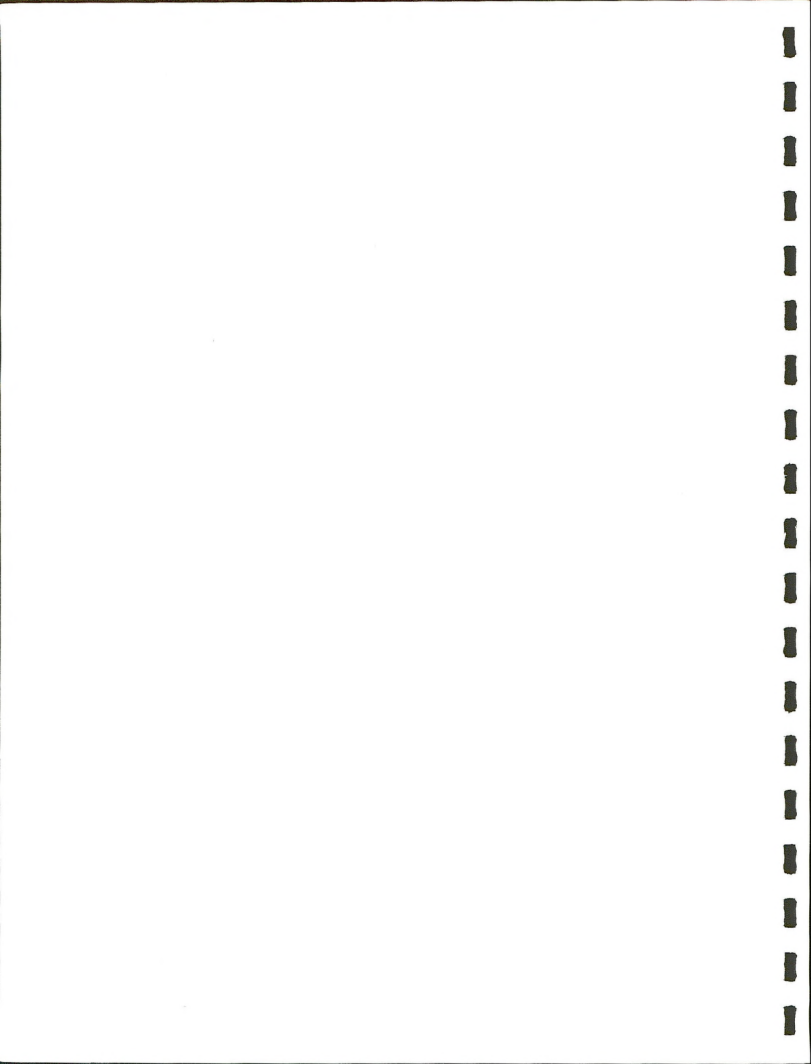


summer 1976 to 600 in summer 1977, with most of the increase occurring on moist sites above 5,600 feet (1,700 m) elevation. Specifically, elk sought out stands of medium to large size lodgepole pine or mature subalpine fir-Engelmann spruce, both with an overstory canopy cover greater than 75 percent and a moist understory such as mountain arnica, arrowleaf groundsel, fool's huckleberry, and wavy-leaved alder. The favored habitat types were Abies lasiocarpa/
Menziesia ferruginea and Abies lasiocarpa/Calamagrostis canadensis. In addition, the clearcuts in upper Chamberlain became very attractive as a food source during late July and August 1977. Elk were seen in the clearcuts on 13 of 14 early morning and late evening visits during August. The cuts produce abundant succulent forage at that time, primarily black elderberry and fireweed. By late August, the elderberry was almost defoliated and elk use appeared to decrease. Such heavy use of the clearcuts was not apparent in 1976 and it is not clear whether the increase was due to a change in habitat preferences or due to more intensive use of the surrounding area during 1977. Several recent radiotelemetry studies in western Montana and northern Idaho have found elk use to be significantly less than the availability of clearcuts (Biggins 1975, Marcum 1975, Hershey and Leege 1976). However, some evidence exists to indicate that particular individual cuts may receive intensive use. Kirsch (1962) reported a peak in elk use of clearcuts during July, particularly cuts associated with mesic

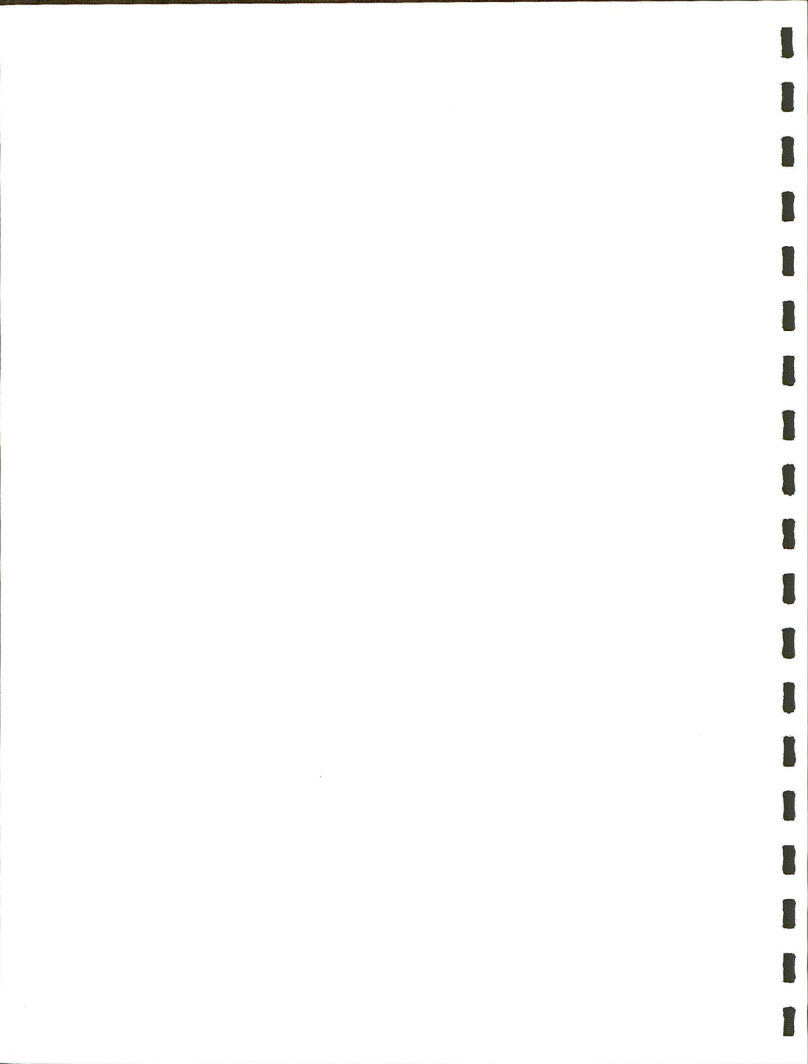


drainage heads on north slopes. By late August, use had declined. The elk preference for clearcuts was almost twice as great as that for unlogged areas in the Blue Mountains of eastern Oregon and Washington (Edgerton 1972). These clearcuts produced a high volume of preferred forage, primarily forbs (Canada milkvetch) and shrubs (elderberry). Day (1973) noted comparatively heavy use of clearcut areas in close proximity to heavy timber cover, natural openings, and mesic meadows. Fireweed was fed on intensively during July and August. The clearcut at the northern end of the study area did not appear to receive intensive elk use during 1977. This cut did not produce the abundant succulent forage characteristic of the cuts at the opposite end of the study area. Lyon (1975) demonstrated that one of the most important determinants of elk use within a clearcut is the level of elk use in the surrounding area. The area surrounding the lightly used cut in Chamberlain is also lightly used during the summer and vice-versa for the heavily used cuts. Apparently, clearcuts located within the normal summer range of elk, near heavy cover, and on moist sites apt to produce abundant succulent forage, are most likely to receive summer elk use, particularly if human access and slash depths are not excessive.

Throughout the year, Subunit 8 receives significant elk use (Figs. 3-7). This is also the area on which the most extensive timber harvest will occur. Considerable habitat diversity already exists



within the area because of the pattern of alternating finger ridges and drainages, swales and benches. Open foraging areas are more common here than elsewhere in Chamberlain and cover and water are abundant. Considering the existing patterns of habitat diversity and intensive elk use, it seems unlikely that timber harvest can initially benefit the elk using Subunit 8. Elk use will probably decrease during logging and remain lower than current levels of use for some time afterward. The next area to the south, Subunit 9, is primarily a summering area for elk wintering on Blacktail Mountain and in lower Bear Creek. Dense stands of small lodgepole pine dominating much of the subunit are interspersed with moist stringers of more open lodgepole pine, subalpine fir-Engelmann spruce, and small meadows. The three latter types are heavily used during the summer for feeding and as travel lanes. Because of the "doghair" lodgepole stands, little movement occurs between Subunit 9 and the adjacent Pearson Creek drainage except at Bear Wallows, a critical point on the ridgeline culminating a long travel lane formed by the stream bottom. Current logging plans call only for a road crossing through the northwest corner of the subunit. This subunit may well become an important security area for elk during timber harvest in other parts of the Chamberlain Creek drainage. Future logging plans should take into consideration the importance of the Bear Wallows area. Subunit 10 is a long, broad slope broken by a few rather shallow draws. The

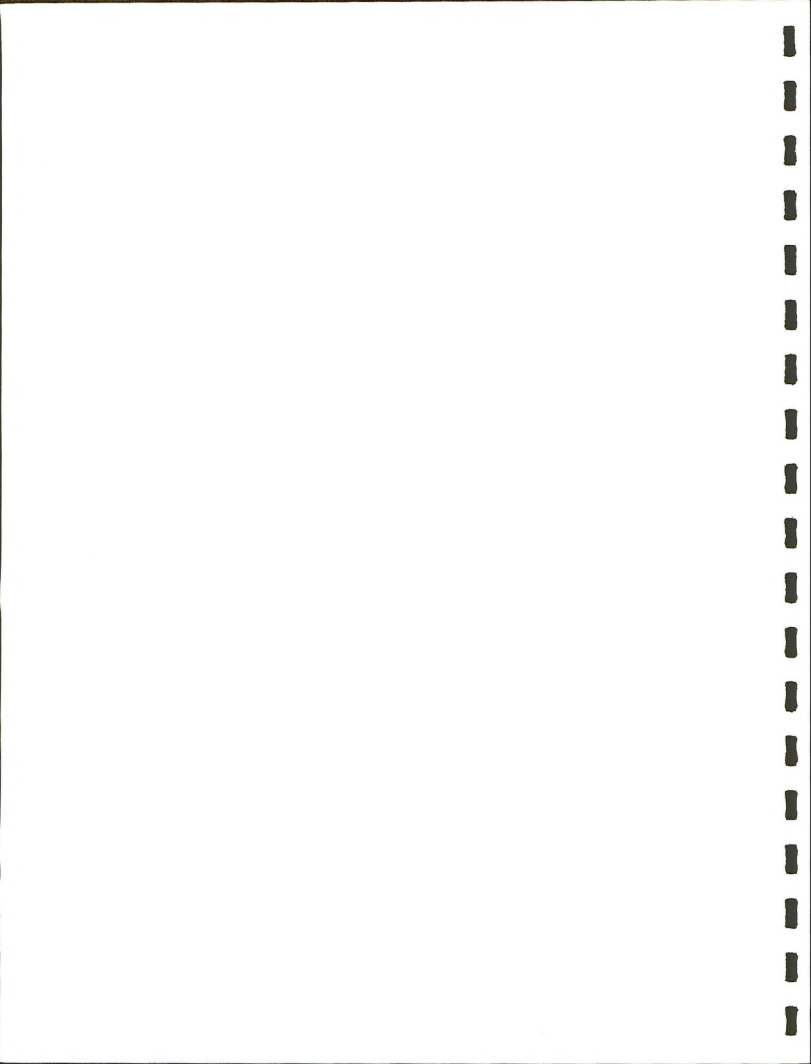


overstory is almost entirely a closed canopy of lodgepole pine. Overstory removal on moist sites might stimulate forage production and increase elk use of the subunit. However, only two small commercial thinnings and a 4-acre shelterwood cut are currently scheduled in Subunit 10. The shelterwood cut will be in an island of mature spruce-fir surrounded by dense lodgepole pine. For this reason, plus its location on the saddle of a ridgeline, the cutting unit is already intensively used by elk. Thus, the cut plus the accompanying road through the saddle will probably depress elk use in the immediate area. Subunits 3 and 4 are also dominated primarily by lodgepole pine. The planned cutting units are on moist sites and overstory removal should be extensive enough to stimulate forage production. Elk use of this area may well be enhanced once the initial disturbance is over. However, further cutting too soon in the future could adversely affect elk by reducing available cover. The area along the western boundary of Subunit 3 north of Lost Horse Mountain is an important crossing point for animals traveling between Fish Creek and upper Chamberlain Creek and should be protected from disturbance. Subunits 1 and 2 receive generally light elk use and I do not anticipate that the logging activity scheduled there will have a significant influence. The head of Chamberlain Creek had elk use proportionate to availability during spring and summer 1977 but received only negligible use during summer 1976 and apparently also during previous years (Ellison 1975).



Streams, seeps, wet meadows, and dense cover are common and an abundant forage supply (the Chamberlain Burn) is nearby. Some other factor appears to be limiting elk use of the area. The cutting units are in areas dominated by very dense alder thickets which receive slight elk use. Consequently, I feel that these units also will have little influence on elk.

The Chamberlain Creek drainage appears to be an important summering area for elk using the winter ranges to the north and west (Marcum et al. 1978). Animals wintering on Blacktail Mountain and lower Bear Creek summer within the study area east of Chamberlain Creek. Elk from Warren, Fish, and Little Fish creeks summer in the upper half of Chamberlain Creek drainage. Very little movement occurs past Chamberlain into the drainages to the east and south. During dry years, Chamberlain becomes even more important and is used longer and more intensively than during other years. The overall impact of logging in Chamberlain Creek drainage should not be particularly detrimental to elk providing that timber harvest and related activities are accomplished as quickly as possible, slash along roads and in cutting units is adequately disposed of, vehicle access is blocked immediately after the completion of logging, and cattle are prevented from entering the area. In addition to the recommendations of the Montana Cooperative Elk-Logging Study (Anon. 1978), I suggest that during timber harvests on elk summer range an effort should be



made to avoid placing roads or cutting units on benches (particularly moist benches), swales, and the ridgelines of "finger" ridges.



CHAPTER VI

SUMMARY

Elk habitat selection and use of an undisturbed, forested summer range was studied during June, July, and August of 1976 and 1977 in the Chamberlain Creek drainage of western Montana. Belt transects extending diagonally across the study area at $\frac{1}{4}$ mile (400 m) intervals were used to sample environmental attributes as well as to count elk pellet groups. The proportion of availability of a habitat attribute was compared to the proportion of elk use occurring in that type. Fresh and new (FN) pellet groups were considered to be no older than 2 months while old and very old (OVO) groups were of indeterminate age. Spring FN and summer FN pellets represented May-June and July-August elk use respectively. Both spring and summer OVO pellet groups more nearly represented total yearly elk use rather than a particular season of use.

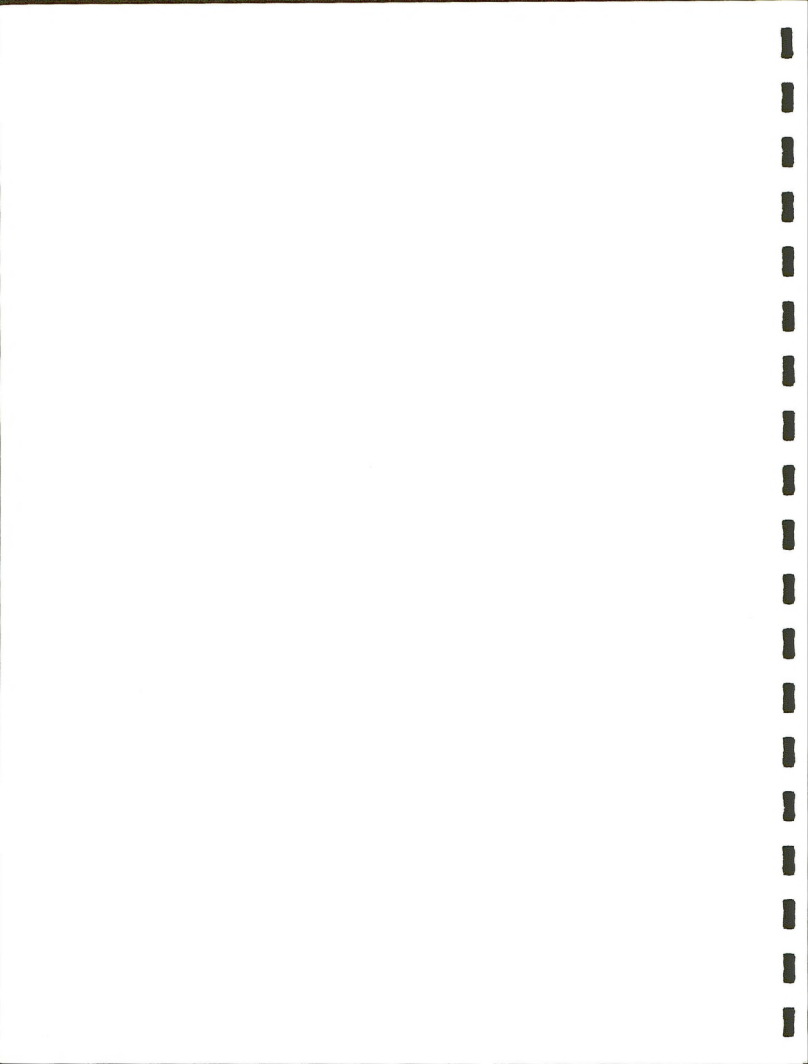
Virtually all available habitats in Chamberlain Creek drainage are used by elk at one time or another. While no environmental situation is preferred over all seasons, some situations are consistently avoided. Use is always lower than availability on slopes in excess of 30°, primary upper slopes and ridgetops, dense stands of



... so he
overlooked a
few things.

small lodgepole pine (pine-sapling successional stage), farther than 450 yards (410 m) from water. Apart from the few topographic features which are avoided, seasonal habitat use patterns appear to be based primarily upon a combination of weather plus vegetation composition, structure, and phenology.

During spring (May and June) 1977, FN pellet groups were found primarily on westerly aspects above 5,000 feet (1,500 m) elevation, particularly in Subunit 10. The most preferred sites were clearings, either bunchgrass meadows on dry west-facing slopes at lower elevations or wet meadows or seeps dominated by bluejoint reedgrass, arrowleaf groundsel, and occasionally mountain arnica at higher elevations. Similarly, the preferred habitat types were Pseudotsuga menziesii/Festuca idahoensis and Abies lasiocarpa/Calamagrostis canadensis. Sight distances of over 100 yards (90 m) were preferred while sight distances of 50 to 100 yards (45-90 m) were used significantly less than their availability. In addition to steep slopes, primary ridgetops, and dense stands of small lodgepole pine, use was also less than availability on beargrass, whortleberry, and globe huckleberry understories (Abies lasiocarpa/Xerophyllum tenax-Vaccinium globulare habitat type). Although mid-slope stands of medium to large size lodgepole pine with fool's huckleberry and alder understories (Abies lasiocarpa/Menziesia ferruginea habitat type) received a substantial portion of the spring elk use, these stands were



neither selected for nor against. The most important feature of the sites selected by elk during the spring seemed to be sparse overstory canopy cover (under 25%), possibly because the understory vegetation was more advanced in the openings than under a closed forest canopy.

During the summer (July and August), elk use shifted to more closed overstory canopies, primarily into stands of medium to large size lodgepole pine on west and northerly aspects. Those stands typically had sight distances of 50 to 100 yards (45-90 m) and were classified as a young successional stage. Even though stands of medium to large size lodgepole pine comprised 43 percent of the study area, elk use during July and August greatly exceeded the availability of those stands. The most preferred understory type during the summer was mountain arnica, for which elk use was twice the availability. During 1976, beargrass and heart-leaf arnica types also received use in excess of their availability. The emphasis was on slightly moister understories during 1977, primarily mountain arnica, fool's huckleberry, wavy-leaved alder, and arrowleaf groundsel. Elk readily fed on the arnica and groundsel and appeared to use the shrubs for bedding cover. The pellet count also tended to be higher on benches, swales, and moderate slopes. As during the spring, steep slopes, dense stands of small lodgepole pine, primary ridgetops, and areas further than 450 yards (410 m) from water were avoided. Elk use was generally less than availability on brush-seedling and old



successional stages, clearings, Douglas-fir-larch stands, and bunchgrass understories (Pseudotsuga menziesii habitat types). This probably reflects the strong elk preference for open lodgepole pine stands rather than an actual avoidance of those situations.

Fall and winter elk use (limited within the study area) was less well defined by pellet counts than spring and summer use. However, fall-winter elk use clearly shifted away from the lodgepole pine and spruce-fir types to open Douglas-fir-larch types on southwest and west aspects at lower elevations. The most preferred sites were the most exposed ones, clearings or stands of scattered large Douglas-fir on secondary upper slopes and ridgetops. The understory on those sites was typically some combination of bunchgrasses, pinegrass, and elk sedge (Pseudotsuga menziesii/Festuca idahoensis habitat type). Sight distances in excess of 100 yards (90 m), the old successional stage, and overstory canopy cover under 25 percent were all used in excess of their availability.

In addition to seasonal shifts in elk habitat use, yearly shifts were also evident in response to weather conditions. Although snow depths were lower than normal during both years, the precipitation during the first part of 1976 was near normal while 1977 was much drier than usual. Elk appeared to respond to the drier conditions during 1977 by moving earlier than usual into upper Chamberlain Creek drainage from the drainages to the north and west. Elk also appeared



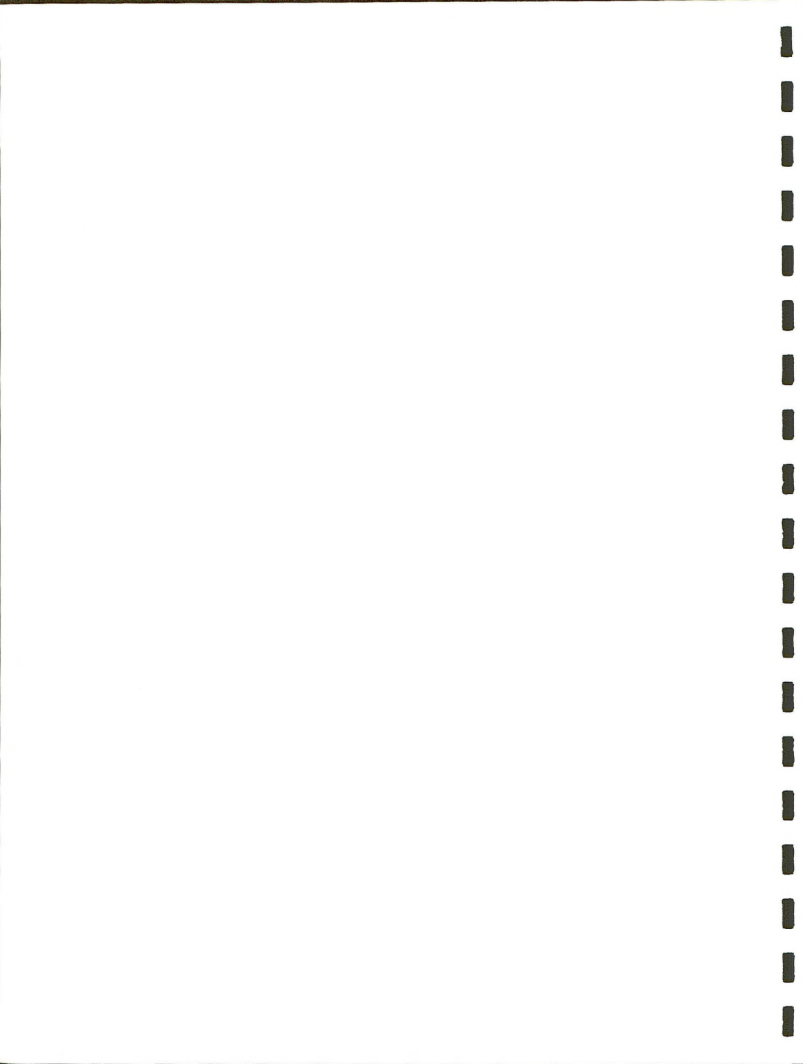
to remain within the Chamberlain Creek drainage more consistently than in other years. The FN pellet count for July and August 1977 was triple the tally for 1976. The greatest increase in use was in the more moist habitats at 5,700 to 6,200 feet elevation (1,700-1,900 m). Specifically, elk sought out stands of medium to large size lodgepole pine or mature subalpine fir-Engelmann spruce stands, both with an overstory canopy greater than 75 percent and a moist understory such as mountain arnica, arrowleaf groundsel, fool's huckleberry, and wavy-leaved alder. The favored habitat types were Abies lasiocarpa/Menziesia ferruginea and Abies lasiocarpa/Calamagrostis canadensis. The early movement into Chamberlain Creek drainage may well have been a response to desiccation of forage vegetation on the more arid slopes of the drainages to the west and north. Elk appeared to be feeding very heavily on succulent forbs during July and August 1977. In addition to arnica and groundsel found in the forest understory, elk almost daily moved into the two southern clearcuts in the evening and early morning to feed on fireweed, black elderberry, and a few short willow plants. The elderberry, though abundant in the cuts, was almost defoliated by the end of August 1977. Such heavy use was not apparent in 1976.

Neither deadfall height nor deadfall ground cover appeared to restrict elk use in Chamberlain. However, the sample size of areas with very heavy deadfall was not large enough to adequately assess elk



response.

Chamberlain Creek drainage is an important summering area during years when precipitation is normal and it becomes even more important during dry years. The overall impact of planned logging in the Chamberlain area should not be particularly detrimental to elk providing that timber harvest is accomplished as quickly as possible, slash is disposed of, road closures are maintained, and cattle continue to be excluded. During this and future timber harvests, an effort should be made to avoid placing roads or cutting units on benches (particularly moist benches), swales, and the ridgelines of "finger" ridges.



REFERENCES CITED

- Anonymous. 1978. Elk management recommendations for the consideration of land managers. Pages ix-xvi in Mont. Coop. Elk-Logging Study Prog. Rpt. for the Period Jan. 1 - Dec. 31, 1977. For. Sci. Lab., Univ. of Mont., Missoula.
- Beall, R. C. 1974. Winter habitat selection and use by a western Montana elk herd. Ph.D. Dissertation, Univ. of Mont., Missoula. 197 pp.
- Biggins, D. E. 1975. Seasonal habitat relationships and movements of the Spotted Bear elk herd. Mont. Fish and Game Dept. Job Final Rpt. W-120-R-6 and 7. 90 pp.
- Bohne, J. R. 1974. Food habits, seasonal distribution, and habitat utilization of elk in the South Fork of Fish Creek, Lolo National Forest, Montana. Mont. Fish and Game Dept., Helena. Job Final Rpt. W-120-R-2 and 3. 187 pp.
- Burbridge, W. R., and D. J. Neff. 1976. Coconino National Forest-Arizona Game and Fish Department Cooperative Roads-Wildlife study. Pages 44-57 in Proc. Elk-Logging-Roads Symp. For., Wildl. and Rge. Expt. Sta., Univ. of Id., Moscow.
- Day, T. A. 1973. Use of clearcuts by elk in the Little Belt Mountains, Montana. M.S. Thesis, Mont. St. Univ., Bozeman. 70 pp.
- Edgerton, P. J. 1972. Big game and habitat changes in a recently logged mixed conifer forest in northeastern Oregon. Pages 239-246 in Western Proc., 52nd Ann. Conf. of Western Assoc. of State Fish and Game Commissioners, Portland.
- Ellison, R. L., L. A. Rhein, and D. C. Sall. 1972. Job II-D, Chamberlain Creek Study. Pages 99-113 in Mont. Coop. Elk-Logging Study Prog. Rpt. for the Period Jan. 1 - Dec. 31, 1971. Bur. of Land Manage., Missoula, Mont.



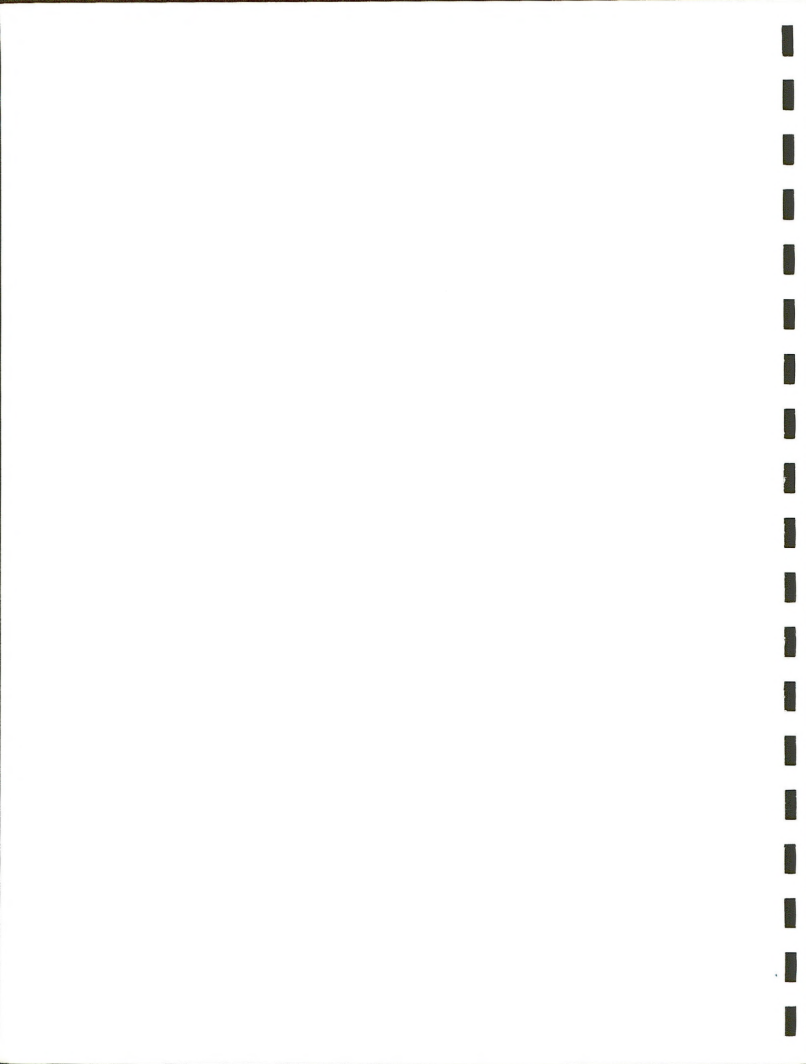
- Ellison, R. L. 1974. Job II-D, Chamberlain Creek Study. Pages 105-125 in Mont. Coop. Elk-Logging Study, Prog. Rpt. for the Period Jan. 1 - Dec. 31, 1973. Bur. of Land Manage., Missoula, Mont.
- _____. 1975. Job II-D, Chamberlain Creek Study. Pages 79-118 in Mont. Coop. Elk-Logging Study Prog. Rpt. for the Period Jan. 1 - Dec. 31, 1974. Bur. of Land Manage., Missoula, Mont.
- Ferguson, R. B. 1955. The weathering and persistency of pellet groups as it affects the pellet group count method of censusing mule deer. Utah Acad. Sci., Arts, and Letters. 32:59-64.
- Hash, H. S. 1973. Movements and food habits of the Lochsa Elk. M.S. Thesis. Univ. of Id., Moscow. 76 pp.
- Hershey, T. J., and T. A. Legee. 1976. Influences of logging on elk on summer range in north-central Idaho. Pages 73-80 in Proc. Elk-Logging-Roads Symp. For., Wildl. and Rge. Expt. Sta., Univ. of Id., Moscow.
- Joslin, G. L. 1975. Behavior and environmental selection by elk (Cervus canadensis nelsoni) during summer and fall in the First and Second Yellow Mule Drainages, Madison County, Montana. M.S. Thesis. Mont. St. Univ., Bozeman. 65 pp.
- Julander, O., and D. E. Jeffery. 1964. Deer, elk, and cattle range relations on summer range in Utah. Trans. N. Am. Wildl. Nat. Resour. Conf. 29:404-414.
- Kirsch, J. B. 1962. Range use, relationship to logging, and food habits of the elk in the Little Belt Mountains, Montana. Mont. Fish and Game Dept., Helena. Job Compl. Rpt. W-98-R-2. 44 pp.
- Kufeld, R. C. 1968. Use of paint for marking deer pellet groups. J. Wildl. Manage. 32(3):592-596.
- Lemke, T. O. 1975. Movement and seasonal ranges of the Burdette Creek elk herd, and an investigation of sport hunting. Mont. Fish and Game Dept., Helena. Job Final Rpt. W-120-R-6. 127 pp.



- Lonner, T. N. 1975. Job II-B, Long Tom Creek Study. Pages 25-72 in Mont. Coop. Elk-Logging Study Prog. Rpt. for the Period Jan. 1 - Dec. 31, 1974. Mont. Fish and Game Dept., Helena.
- _____. 1976. Job II-B, Long Tom Creek Study. Pages 15-56 in Mont. Coop. Elk-Logging Study Prog. Rpt. for the Period Jan. 1 - Dec. 31, 1975. Mont. Fish and Game Dept., Helena.
- _____. 1977. Job II-B, Long Tom Creek Study. Pages 25-68 in Mont. Coop. Elk-Logging Study Prog. Rpt. for the Period Jan. 1 - Dec. 31, 1976. Mont. Fish and Game Dept., Helena.
- Lyon, L. J. 1973. Job II-A, Proc. B-1, Conduct annual pellet count surveys to describe elk distribution patterns within the Burdette Creek-Deer Creek area. Pages 26-45 in Mont. Coop. Elk-Logging Study Prog. Rpt. for the Period Jan. 1 - Dec. 31, 1972. For. Sci. Lab., Univ. of Mont., Missoula.
- _____. 1974. Job II-A, Proc. B-1, Conduct annual pellet count surveys to describe elk distribution patterns within the Burdette Creek-Deer Creek area. Pages 10-28 in Mont. Coop. Elk-Logging Study Prog. Rpt. for the Period Jan. 1 - Dec. 31, 1973. For. Sci. Lab., Univ. of Mont., Missoula.
- _____. 1975. Job III-B, Elk use of disturbed areas. Pages 121-131 in Mont. Coop. Elk-Logging Study Prog. Rpt. for the Period Jan. 1 - Dec. 31, 1974. For. Sci. Lab., Univ. of Mont., Missoula.
- _____. 1976. Job II-A, Proc. B-1, Conduct annual pellet count surveys to describe elk distribution patterns within the Burdette Creek-Deer Creek area. Pages 5-7 in Mont. Coop. Elk-Logging Study Prog. Rpt. for the Period Jan. 1 - Dec. 31, 1975. For. Sci. Lab., Univ. of Mont., Missoula.
- _____. 1978. Job II-A, Proc. B-1, Conduct annual pellet count surveys to describe elk distribution patterns within the Burdette Creek-Deer Creek area. Pages 5-7 in Mont. Coop. Elk-Logging Study Prog. Rpt. for the Period Jan. 1 - Dec. 31, 1977. For. Sci. Lab., Univ. of Mont., Missoula.
- Mackie, R. J. 1970. Range ecology and relations of mule deer, elk and cattle in the Missouri River Breaks, Montana. Wildl. Mono. 20. 79 pp.



- Marcum, C. L. 1975. Summer-fall habitat selection and use by a western Montana elk herd. Ph.D. Dissertation, Univ. of Mont., Missoula. 188 pp.
- _____, M. D. Scott, and J. Lehmkuhl. 1978. Job II-D, Chamberlain Creek Study. Pages 55-113 in Mont. Coop. Elk-Logging Study, Prog. Rpt. for the Period Jan. 1 - Dec. 31, 1977. School of For., Univ. of Mont., Missoula.
- Neff, D. J. 1968. The pellet-group count technique for big game trend, census, and distribution: a review. J. Wildl. Manage. 32(3):592-614.
- Nie, N. H., C. H. Hull, J. G. Jenkins, K. Steinbrenner, and D. H. Bent. 1975. SPSS: Statistical package for the social sciences. Second Edition. McGraw-Hill, Inc., New York. 675 pp.
- Patric, E. F., and R. W. Bernhardt. 1960. Persistence of winter deer-pellet groups in Adirondack Forests. New York Fish and Game Jour. 7(1):80-82.
- Perry, C., and R. Overly. 1976. Impact of roads on big game distribution in portions of the Blue Mountains of Washington. Pages 62-68 in Proc. Elk-Logging-Roads Symp. For., Wildl. and Rge. Expt. Sta., Univ. of Id., Moscow.
- Pfister, R. D., B. L. Kovalchik, S. F. Arno, and R. C. Presby. 1977. Forest habitat types of Montana. Intermountain For. and Rge. Expt. Sta. and U.S.D.A. For. Serv. Gen. Tech. Rpt. INT-34. May 1977. 174 pp.
- Robinette, W. L., R. B. Ferguson, and J. S. Gashwiler. 1958. Problems involved in the use of deer pellet group counts. Trans. N. Am. Wildl. Conf. 23:411-425.
- Simmons, C. A. 1974. Seasonal movements and migrations of the Spotted Bear Elk Herd. Mont. Fish and Game Dept., Helena. Job Final Rpt. W-120-R-5 and 6. 90 pp.
- Snedecor, G. W., and W. G. Cochran. 1967. Statistical methods: sixth edition. The Iowa St. Univ. Press, Ames. 593 pp.



- Steele, R. W. 1978. Weather data summary 1956-1978 (Incl.)
Lubrecht Experimental Forest, Greenough, Montana. Mont. For.
and Cons. Expt. Sta. Misc. Paper No. 11. School of For.,
Univ. of Mont., Missoula. 36 pp.
- Stevens, D. R. 1966. Range relationships of elk and livestock,
Crow Creek Drainage, Montana. J. Wildl. Manage. 30(2):349-
363.
- Thomas, J. W., R. J. Miller, H. Black, J. E. Rodiek, and C. Maser.
1976. Guidelines for maintaining and enhancing wildlife habitat
in forest management in the Blue Mountains of Oregon and
Washington. Trans. N. Am. Wildl. and Nat. Res. Conf. 41:452-
476.
- Van Etten, R. C., and C. L. Bennett, Jr. 1965. Some sources of
error in using pellet-group counts for censusing deer. J. Wildl.
Manage. 29(4):723-729.
- Wallmo, O. C., A. W. Jackson, T. L. Hailey, and R. L. Carlisle.
1962. Influence of rain on the count of deer pellet groups.
J. Wildl. Manage. 26(1):50-55.
- White, K. L. 1960. Differential range use by mule deer in the
spruce-fir zone. Northwest Sci. 34(4):118-126.
- Young, V. A., and W. L. Robinette. 1939. A study of the range
habits of elk on the Selway Game Preserve. Univ. of Id., School
of For. Bull. No. 9. 47 pp.
- Zahn, H. M. 1974. Elk habitat and forage relationships in a timber-
browse range in western Montana. Mont. Fish and Game Dept.,
Helena. Job Final Rpt. W-120-R-4 and 5. 71 pp.



APPENDIX I

Tables 9-23 provide numerical values corresponding to Figs. 4 and 8-21 in the text.

The following convention was used to indicate the statistical significance of the difference between the proportion of availability of a habitat attribute and the proportion of elk use of that attribute.

+ or - indicates elk use significantly greater or less than availability, $p \leq 0.05$

++ or -- indicates elk use significantly greater or less than availability, $p \leq 0.01$

lack of a sign indicates no significant difference.

Su 76 = Summer 1976

Sp 77 = Spring 1977

Su 77 = Summer 1977



Table 9. Percentages of availability and elk use related to subunits during 1976-1977.

Subunit	% Availability	% FN elk use			% OVO elk use		
		Su 76	Sp 77	Su 77	Su 76	Sp 77	Su 77
1	8.7	5.5	11.9	-- 0.3	11.5	8.7	8.5
2	9.0	9.4	5.2	-- 2.3	5.8	- 4.6	6.1
3	9.0	14.4	-- 2.2	12.9	8.5	8.4	9.2
4	6.4	7.0	5.6	+12.0	4.9	6.6	6.9
5	2.5	0.5	4.3	1.5	0.5	1.2	2.0
6	3.2	5.5	5.1	5.5	0.9	1.9	2.6
7	1.2	0.0	0.0	0.3	0.2	0.2	0.1
8	15.6	19.4	14.1	-- 6.2	++29.9	++28.6	++24.8
9	14.9	17.9	10.1	++26.0	15.3	15.4	13.2
10	15.8	19.4	++30.1	17.0	15.6	14.6	14.7
11	13.7	-- 1.0	11.4	16.0	-- 6.9	9.8	11.9
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0



Table 10. Percentages of availability and elk use related to elevation during 1976-1977.

Elevation (in feet)	% Availability	% FN elk use			% OVO elk use		
		Su 76	Sp 77	Su 77	Su 76	Sp 77	Su 77
4,500-5,000 (1,370-1,520 m)	9.1	- 4.0	-- 0.5	-- 0.0	12.1	11.3	9.4
5,100-5,600 (1,550-1,700 m)	22.5	27.4	25.5	-- 8.2	+28.9	25.1	24.5
5,700-6,200 (1,740-1,890 m)	50.2	52.7	54.7	++68.0	44.7	46.9	52.6
6,300-6,800 (1,920-2,070 m)	18.2	15.9	19.3	23.8	14.3	16.7	13.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0



Table 11. Percentages of availability and elk use related to slope during 1976-1977.

	% Availability	% FN elk use			% OVO elk use		
		Su 76	Sp 77	Su 77	Su 76	Sp 77	Su 77
0-15°	65.8	68.2	74.6	++80.1	60.3	62.5	66.9
16-30°	30.3	31.3	25.4	--19.2	36.0	33.7	29.9
31-38°	3.9	-- 0.5	-- 0.0	-- 0.7	3.7	3.8	3.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0



Table 12. Percentages of availability and elk use related to aspect during 1976-1977.

Aspect	% Availability	% FN elk use			% OVO elk use		
		Su 76	Sp 77	Su 77	Su 76	Sp 77	Su 77
N	9.2	11.9	12.1	12.0	8.6	8.3	9.1
NE	20.5	20.4	14.1	20.5	18.1	16.7	19.2
E	9.7	9.0	4.1	7.5	7.8	6.4	7.3
SE	6.2	3.0	2.7	- 2.2	5.3	5.3	4.8
S	2.3	3.5	1.6	2.2	0.8	1.4	1.4
SW	15.2	11.4	17.0	10.5	18.4	20.2	18.5
W	16.3	21.9	23.5	17.5	18.3	19.1	19.3
NW	20.6	18.9	24.9	+27.6	22.7	22.6	20.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

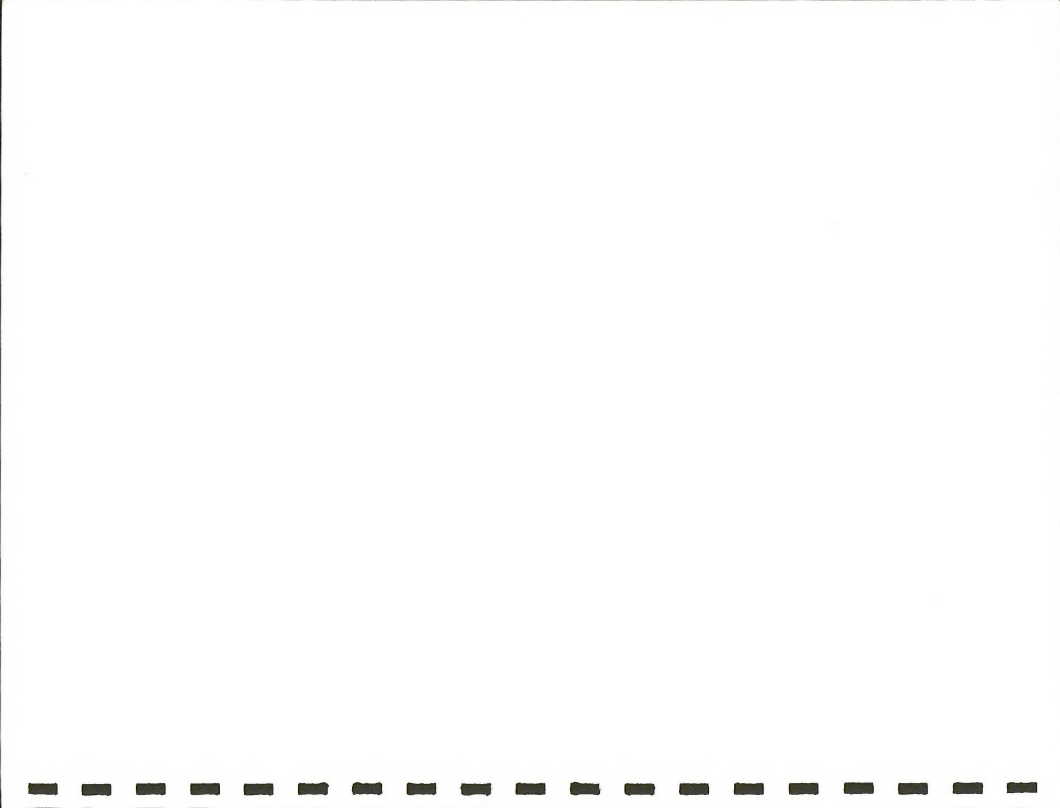


Table 13. Percentages of availability and elk use related to topography during 1976-1977.

Topography	% Availability	% FN elk use			% OVO elk use		
		Su 76	Sp 77	Su 77	Su 76	Sp 77	Su 77
Main stream	4.0	4.0	9.0	4.2	- 1.1	2.5	2.4
Lower slope	6.6	5.0	4.5	4.4	3.6	4.4	4.6
Mid-slope	47.3	47.7	48.6	55.5	46.9	50.0	50.7
Secondary upper slope and ridgetop	12.7	12.0	11.0	-- 6.0	++20.9	+18.1	16.2
Primary upper slope and ridgetop	16.1	10.9	8.9	10.8	12.5	-10.5	--10.1
Bench	5.0	9.9	2.9	6.5	5.1	5.8	6.0
Swale	4.6	6.0	8.8	+ 8.8	7.6	6.4	6.2
Other	3.7	4.5	6.3	3.8	2.3	2.3	3.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0



Table 14. Percentages of availability and elk use related to distance to non-road disturbance during 1976-1977.

Distance to non-road disturbance (in yards)	% Availability	% FN elk use			% OVO elk use		
		Su 76	Sp 77	Su 77	Su 76	Sp 77	Su 77
0-150 (0-140 m)	6.1	4.0	3.6	- 2.7	5.2	4.0	5.3
150-550 (140-500 m)	11.6	-- 4.5	8.7	7.5	9.1	9.6	9.0
550-950 (500-870 m)	15.5	11.4	10.8	11.2	+21.0	18.4	18.9
950-1,350 (870-1,230 m)	15.5	15.4	18.4	14.7	19.0	17.1	18.2
> 1,350 (> 1,230 m)	51.3	++64.7	58.5	++63.9	45.7	50.9	48.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

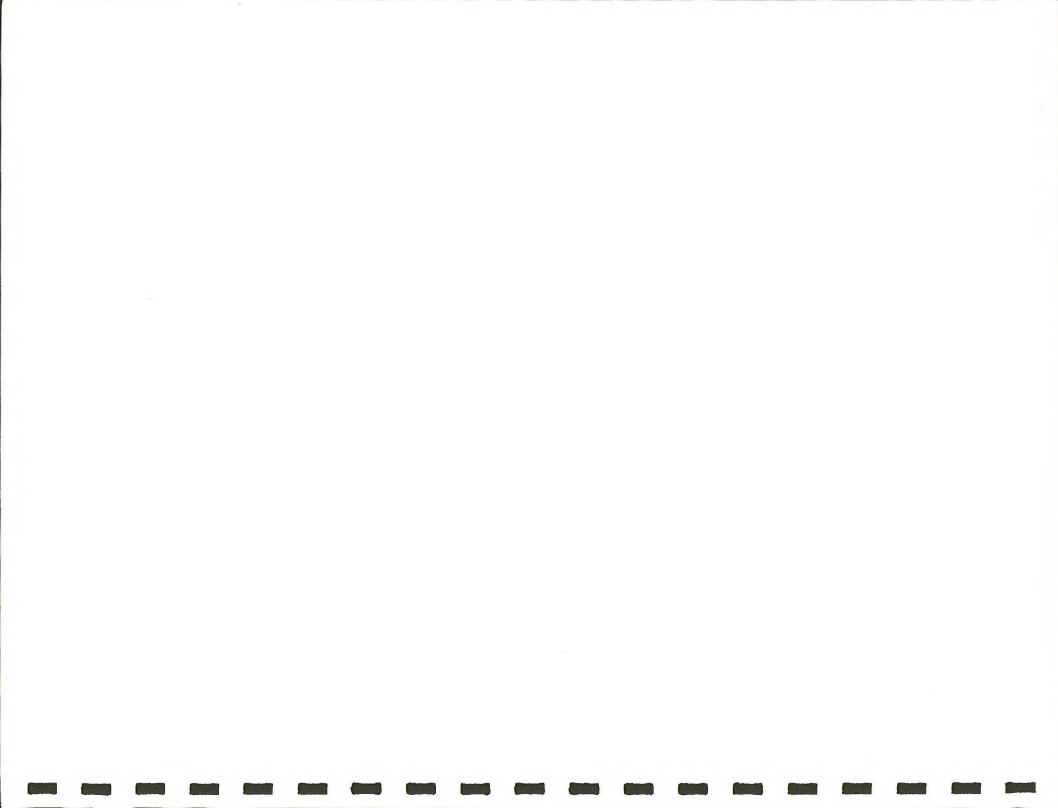


Table 15. Percentages of availability and elk use related to distance to road during 1976-1977.

Distance to road (in yards)	% Availability	% FN elk use			% OVO elk use		
		Su 76	Sp 77	Su 77	Su 76	Sp 77	Su 77
0-150 (0-140 m)	12.4	8.0	- 5.2	- 6.5	- 7.8	-- 7.1	- 7.9
150-550 (140-500 m)	27.4	28.8	24.0	21.7	26.0	29.0	27.2
550-950 (500-870 m)	27.7	23.4	24.2	+36.1	32.6	33.3	31.5
950-1,350 (870-1,230 m)	21.6	28.4	++37.0	+28.7	23.4	23.1	23.8
>1,350 (>1,230 m)	10.9	11.4	9.6	7.0	10.2	7.5	9.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

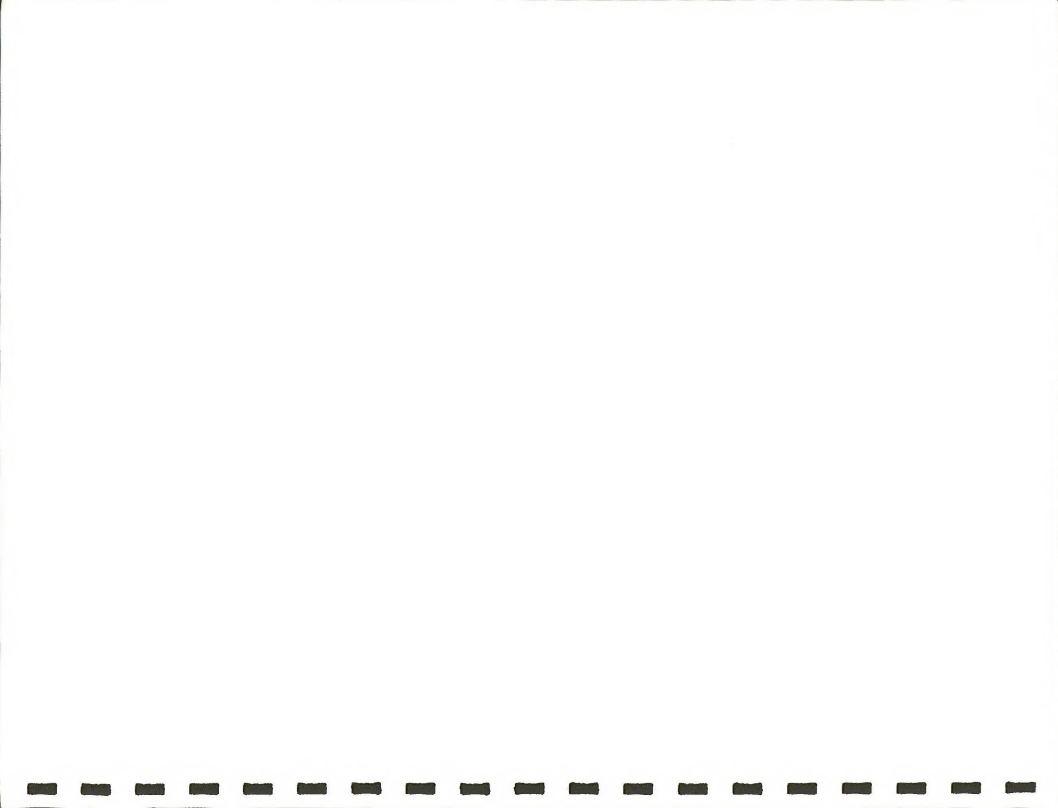


Table 16. Percentages of availability and elk use related to distance to water during 1976-1977.

Distance to water (in yards)	% Availability	% FN elk use			% OVO elk use		
		Su 76	Sp 77	Su 77	Su 76	Sp 77	Su 77
0-50 (0-45 m)	18.3	18.9	26.4	24.3	--10.6	16.1	17.6
50-150 (45-140 m)	23.9	22.4	16.4	-16.2	29.0	24.2	23.4
150-250 (140-230 m)	21.2	22.4	21.8	26.7	24.7	25.0	25.6
250-350 (230-320 m)	15.3	17.4	13.9	15.0	16.8	16.3	15.3
350-450 (320-410 m)	11.6	13.9	18.1	13.3	13.5	12.9	12.9
450-850 (410-780 m)	9.7	5.0	- 3.4	-- 4.5	- 5.4	- 5.5	- 5.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0



Table 17. Percentages of availability and elk use related to overstory canopy cover during 1976-1977.

Overstory canopy cover	% Availability	% FN elk use			% OVO elk use		
		Su 76	Sp 77	Su 77	Su 76	Sp 77	Su 77
0-25%	5.0	3.5	+13.7	3.2	++10.7	+ 8.4	++ 8.8
25-75%	45.0	46.8	42.1	-37.5	50.9	49.6	46.2
>75%	50.0	49.7	44.2	++59.3	--38.4	-42.0	45.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

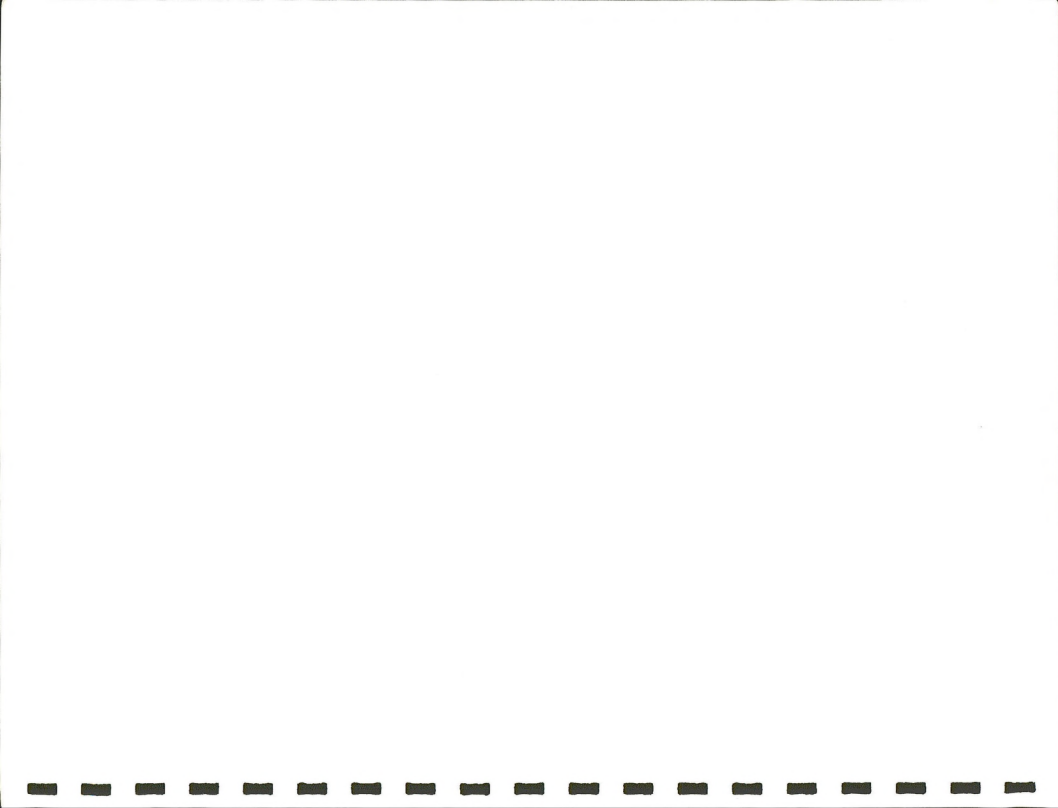


Table 18. Percentages of availability and elk use related to tree stand type during 1976-1977.

Tree stand type	%	% FN elk use			% OVO elk use		
		Su 76	Sp 77	Su 77	Su 76	Sp 77	Su 77
Dense PSME-LAOC	10.8	8.9	8.8	-- 2.3	12.6	10.9	10.6
Moderate PSME-LAOC	9.9	7.5	4.9	-- 1.5	++16.4	12.1	11.4
Scattered large PSME	3.2	3.5	5.2	1.8	++ 7.4	++ 7.9	++ 6.8
Clearing	4.0	2.0	+13.0	2.5	++ 9.0	6.5	+ 7.2
Dense ABLA-PIEN	14.8	9.9	14.1	13.4	-- 8.5	11.4	12.0
Moderate ABLA-PIEN	5.6	2.5	8.3	+10.5	3.5	5.5	4.9
Small to medium PICO	8.4	4.5	- 2.9	5.7	- 3.9	- 4.6	-- 3.9
Medium to large PICO	43.3	++61.2	42.8	++62.3	38.7	41.1	43.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

PSME - Pseudotsuga menziesiiABLA - Abies lasiocarpaPICO - Pinus contortaLAOC - Larix occidentalisPIEN - Picea engelmanni



Table 19. Percentages of availability and elk use related to dominant understory species during 1976-1977.

Dominant understory species	% Availability*	% FN elk use			% OVO elk use		
		Su 76	Sp 77	Su 77	Su 76	Sp 77	Su 77
<u>Festuca idahoensis</u> -							
<u>Agropyron spicatum</u>	5.8	2.0	7.2	-- 0.5	++14.5	++12.3	++10.4
<u>Calamagrostis rubescens</u>	10.1	8.5	9.9	-- 3.2	++16.3	++15.4	13.8
<u>Arnica cordifolia</u>	6.6	8.5	5.6	4.5	7.2	8.5	8.2
<u>Xerophyllum tenax</u>	35.1	41.3	25.1	-26.3	34.6	31.8	30.9
<u>Vaccinium scoparium</u>	17.1	18.4	- 8.3	11.5	13.1	12.0	11.7
<u>Vaccinium globulare</u>	31.9	31.8	24.7	--20.8	30.7	27.5	26.3
<u>Menziesia ferruginea</u>	23.1	22.4	23.6	++37.5	16.8	22.1	22.9
<u>Alnus sinuata</u>	27.7	23.9	31.8	++41.7	23.9	25.7	25.8
<u>Arnica latifolia</u>	11.4	++22.9	19.0	++26.8	10.5	13.8	++17.3
<u>Senecio triangularis</u>	5.2	4.5	++16.6	++14.0	4.4	6.6	6.5
<u>Calamagrostis canadensis</u>	5.0	4.5	9.4	5.7	1.9	2.4	4.2
Other	16.6	10.0	12.8	-- 6.2	20.5	16.4	16.9

*Since the two dominant species on each segment were recorded, the percentages total to more than 100%.

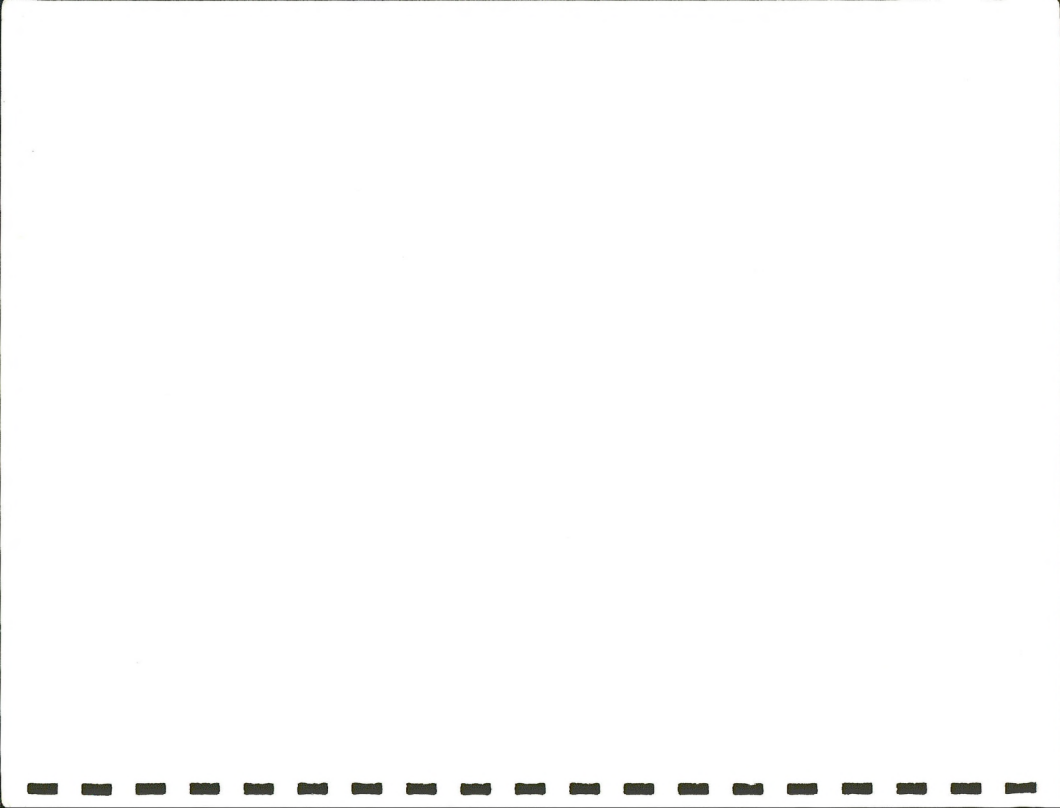


Table 20. Percentages of availability and elk use related to habitat type during 1976-1977.

Habitat type	% Availability	% FN elk use			% OVO elk use		
		Su 76	Sp 77	Su 77	Su 76	Sp 77	Su 77
PSME/FEID	2.5	0.5	2.9	- 0.0	++ 7.8	+ 5.6	4.8
PSME/CARU-AGSP	1.6	1.0	3.8	0.5	++ 5.2	++ 5.8	++ 4.8
PSME/CARU ¹	4.7	5.0	2.3	1.8	6.8	6.2	6.4
PSME/PHMA ²	0.6	0.0	0.7	0.0	0.8	0.9	0.7
PSME/VAGL-XETE ³	1.3	0.0	0.0	0.0	1.5	1.7	1.7
PSME/LIBO ⁴	1.1	2.0	0.0	0.0	1.3	1.0	1.1
PSME/SYAL ⁵	0.9	0.5	0.0	0.0	1.7	1.6	0.9
ABLA/LIBO	1.9	0.5	2.3	2.2	1.1	1.8	2.0
ABLA/LIBO-XETE	14.6	17.4	11.6	-- 6.3	16.3	14.6	15.2
ABLA/XETE-VAGL ⁶	26.0	28.8	15.9	22.5	23.0	20.7	-18.8
ABLA/XETE-VASC	5.0	5.5	4.0	3.5	4.3	3.7	3.9
ABLA/MEFE	24.8	25.3	24.0	++42.2	18.4	24.3	25.4
ABLA/ALSI	4.0	3.0	4.5	5.3	3.0	2.7	3.2
ABLA/CLUN ⁷	1.3	0.5	4.5	1.0	1.1	1.2	1.1
ABLA/CACA-CACA	3.6	5.5	+14.1	++ 9.5	3.4	4.9	5.7
ABLA/CACA-GATR ⁸	2.5	2.5	4.0	3.0	0.9	1.6	1.3
ABLA/CACA-VACA ⁹	1.4	1.5	2.9	1.4	0.4	0.4	1.1
Clearcut	2.0	0.5	2.5	0.8	3.0	1.3	1.9
Rock	0.2	0.0	0.0	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

¹Includes ABLA/CARU²Includes PSME/PHMA-CARU³Includes PSME/VAGL⁴Includes PSME/LIBO-SYAL, PSME/LIBO-VAGL, and PSME/LIBO-CARU⁵Includes PSME/SYAL-CARU and PSME/SYAL-AGSP⁶Includes ABLA/VAGL⁷Includes ABLA/CLUN-ARNU and ABLA/CLUN-MEFE⁸Includes ABLA/GATR⁹Includes ABLA/VACA and wet meadows

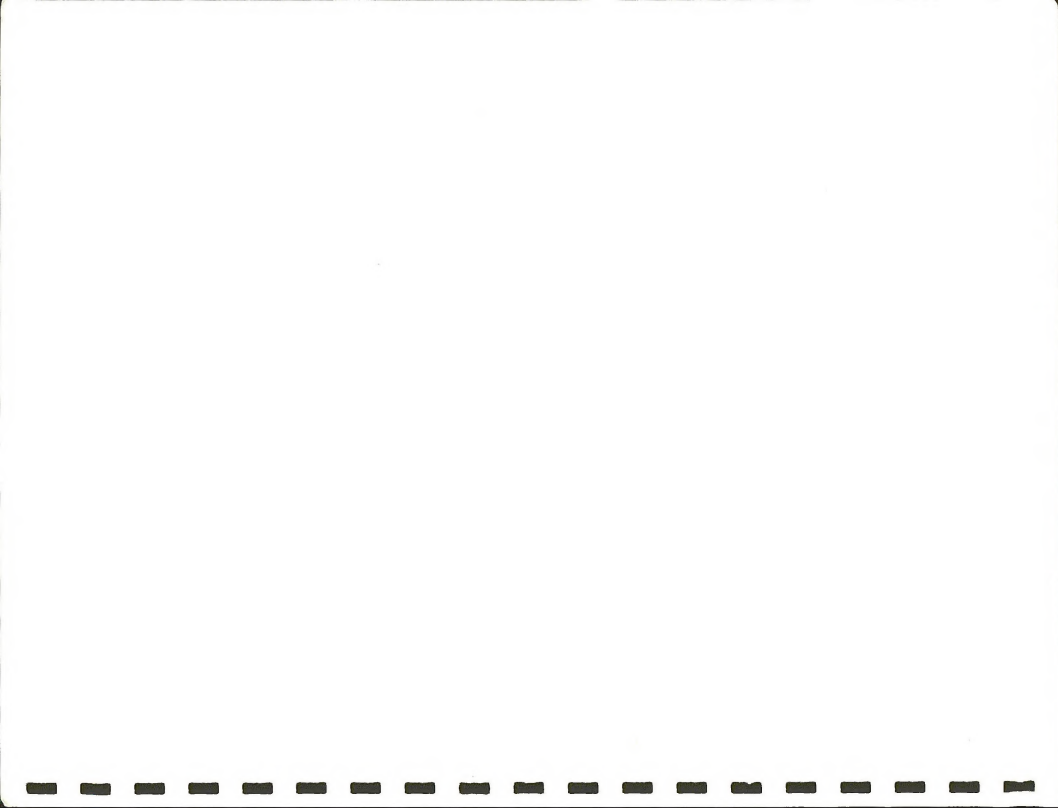


Table 21. Percentages of availability and elk use related to sight distance during 1976-1977.

Sight distance (in yards)	% Availability	% FN elk use			% OVO elk use		
		Su 76	Sp 77	Su 77	Su 76	Sp 77	Su 77
<50 (<46 m)	33.1	-23.4	37.3	27.2	--22.6	-27.0	-26.7
50-100 (46-91 m)	58.3	+69.1	-46.6	++69.1	59.3	56.2	58.1
>100 (>91 m)	8.6	7.5	16.1	-- 3.7	++18.1	++16.8	++15.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

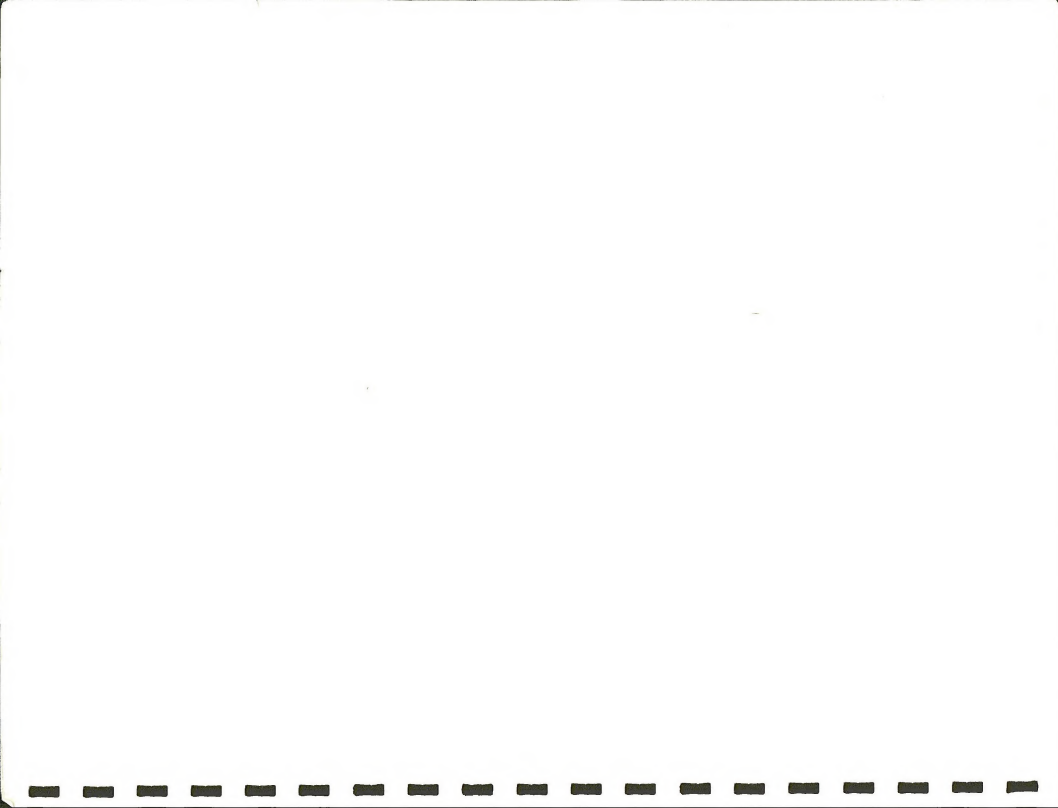


Table 22. Percentages of availability and elk use related to successional stage during 1976-1977.

Successional stage	% Availability	% FN elk use			% OVO elk use		
		Su 76	Sp 77	Su 77	Su 76	Sp 77	Su 77
Brush-seedling	1.8	0.5	2.5	0.8	3.0	1.3	1.8
Pole-sapling	3.3	2.5	-- 0.0	-- 0.5	1.2	1.3	1.4
Young stand	43.5	+56.2	49.1	++62.5	36.9	42.2	41.8
Mature stand	27.6	26.4	-17.5	21.7	27.9	23.0	25.5
Old stand	23.8	-14.4	30.9	--14.5	+31.0	++32.2	29.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

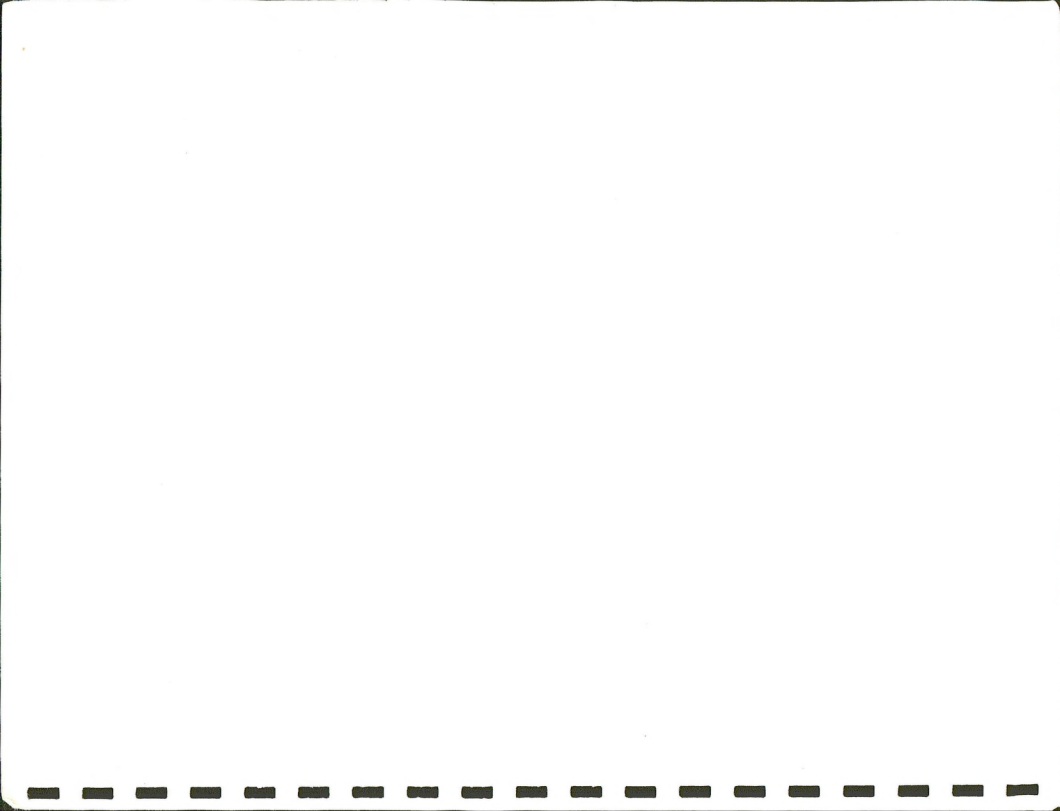


Table 23. Percentages of availability and elk use related to deadfall height and ground cover during 1976-1977.

	% Availability	% FN elk use			% OVO elk use		
		Su 76	Sp 77	Su 77	Su 76	Sp 77	Su 77
<15% cover, <1.5 ft deep	42.7	42.3	48.2	40.3	45.1	44.1	43.6
<15% cover, >1.5 ft deep	6.0	9.9	5.6	2.0	9.0	9.6	8.3
15-35% cover, <1.5 ft deep	24.9	21.9	19.5	32.7	22.0	22.1	21.8
15-35% cover, >1.5 ft deep	12.7	14.4	14.3	9.8	14.1	12.8	13.3
>35% cover, <1.5 ft deep	6.1	6.5	5.4	6.7	3.8	4.4	5.6
>35% cover, >1.5 ft deep	7.6	5.0	7.0	8.5	6.0	7.0	7.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

OL 737 .U55 S367 1976

Elk habitat selection and

use on an undisturbed

9/19/90

David H Ne

BLM LIBRARY
SC-3246

SC-324A, BLDG. 50
DENVER FEDS

DENVER FEDERAL CENTER
P. O. BOX 25047
DENVER, CO 80225

P. O. BOX 25047
DENVER, CO

BOX 25047
DENVER, CO 80225-0047

GAYLORD			PRINTED IN U.S.A.

